FOculus

IEEE 1394 Digital CCD Camera Line

User Operation Manual

For FIREWIRE CCD & CMOS Cameras FOxxx(x)Tx Models

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NEW ELECTRONIC TECHNOLOGY

Legal Notice.

For Customers in U.S.A.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart J of Part 15 of FCC Rules.

For customers in Europe

This apparatus has been certified to meet or exceed the standards for CE compliance per the Council Directives. Pertinent testing documentation is available for verification.

For customers in Canada

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.

Pour utilisateurs au Canada

Cet appareil est conforme aux normes Classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life support applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. NET customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify NET for any damages resulting from such improper use or sale.

Before You Start

This manual should help you in installation and setting of the camera and we recommend you to carefully follow the instruction described.

To ensure that your warranty remains valid, read the manual carefully before using the camera.

DO NOT disassemble, modify or repair the camera since there is no user serviceable part inside and may void warranty. For prevention of fire or electric shock DO NOT remove screws or cover from the camera.

Operation in wet are is NOT recommended and camera SHOULD NOT be exposed to rain or moisture. For prolong life and use of camera's CCD, do not point the camera directly to the sun or strong spotlight which may result CCD blooming and permanent damage. DO NOT operate camera beyond operation temperature range stated and AVOID usage in conditions exceeding 90% humidity.

DO NOT use unregulated power supply source to prevent camera's circuit damage.

Use soft materials such as lens tissue or cotton tipped applicator with ethanol for CCD faceplate cleaning ONLY when necessary and AVOID contact with fingers or any hard object. Do not use solvent, abrasives or detergent in case of cleaning camera body.

Warranty shall be voided for improper usage or fault caused by user or damage caused by other equipments due to negligence

Warranty

NET GMBH warrants the original components free of defects for one year from purchase date. This warranty covers failures and damage due to defect which may occur during normal use. It does not cover damages or failure resulting from mishandling, abuse, misuse or modification. For every repair or replacement, RMA numbers must be obtained in advance.

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1. Introduction

1.1. Overview

NET GmbH's **FOCULUS T SERIES** opens a new horizon to digital image processing providing more features in a small form factor still maintaining the cost effectiveness and high quality. **FOCULUS T SERIES** models are lined up by a wide range of resolution equipped with FIREWIRE™ interface and trigger to suit the need for every application. The **FOCULUS T SERIES** offer the highest frame rate each in its resolution range compared with products from others. The small form factor design has expanded the usage by eliminating limits currently existing due to size and weight which has broaden the application area.

Large selection of cameras is available and scheduled to be added to the **FOCULUS T SERIES** which consist of sensors sensor sizes(1/3", 1/2", 1/1.8") and resolution(VGA, XGA, SXGA, UXGA) both in color and black and white.

The **FOCULUS T SERIES** consist of the following models, which has CCD sensors and CMOS sensors.

FOculus T SERIES	Model Name	CCD(Progressive)	CMOS	Resolution	FPS at Max Res.
Black & White	FO531TB	1/1.8"		1600x1200	16
	FO432TB	1/2"		1388x1040	20
	FO323TB	1/3"		1024 x 768	30
	FO124TB	1/3"		640 x 480	60
	FO1224TB		1/3"	752 x 480	60
	FO1433TB		1/2"	1280 x 1024	24
Color	FO531TC	1/1.8"		1600x1200	16
	FO432TC	1/2"		1388x1038	20
	FO323TC	1/3"		1024 x 768	30
	FO124TC	1/3"		640 x 480	60
	FO1224TC		1/3"	752 x 480	60
	FO1631TC		1/2"	2048 x 1536	10

FOCULUS T CCD SERIES 's unique features are supporting for external trigger mode0~5 and 12,13,14,15, multi camera auto-sync, oneshot and multishot, wide range of shutter speed, RS232C pass through via FIREWIRE™, Fast format 7 partial scan, High speed up trigger frame rate, which would provide maximum flexibility in applications and Industrial screw lock cable support has been added for more reliable connectivity. **FOCULUS T SERIES** 's firmware can be upgraded via FIREWIRE™ and latest versions are available through our website together with NET Gmbh's SDK and demo applications. **FOCULUS T CMOS SERIES** 's unique features also are supporting for the similar functions **FOCULUS T CCD SERIES** is supporting.

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1.2. Components

Components in our package

The following components are included in our package

FOCULUS T Series

CAMERA UNIT

Detachable Filter

(Dummy Filter for B/W Series

Optical Low Pass filter for Color Models).

FIREWIRE™ Digital Imaging CD

Driver

Demo Software

FOSDK API Library

Manuals

User Manual

Downloadable Software

Latest Update of Firmware and Demo Applications are available on our website.

http://www.net-gmbh.com http://www.net-usa-inc.com

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1.3. Optional Accessories

Machine Vision CCD Lens

FIREWIRE™ OHCI Adapter

FIREWIRE™ PC-Card Bus Adapter

FIREWIRE™ Cable

FIREWIRE™ Genders

FIREWIRE™ Hub Repeater

Tripod Plate

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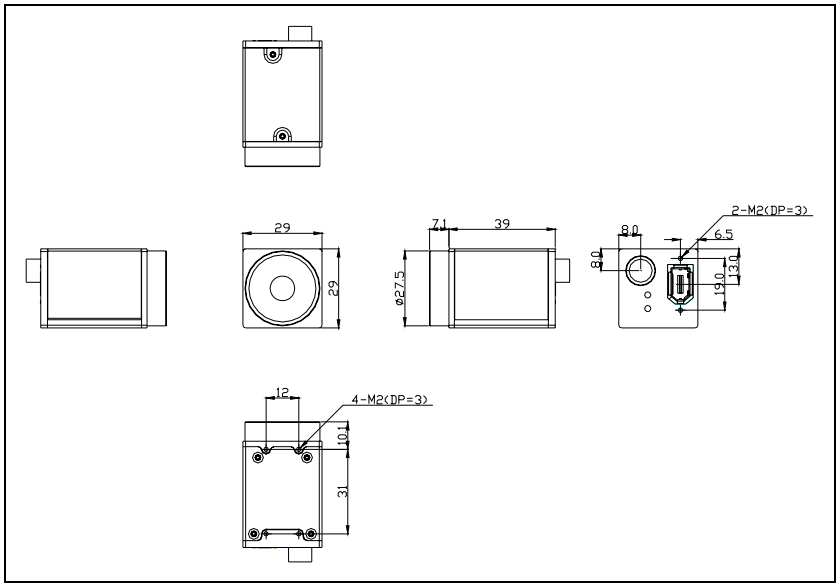
1.4. Dimension and Description

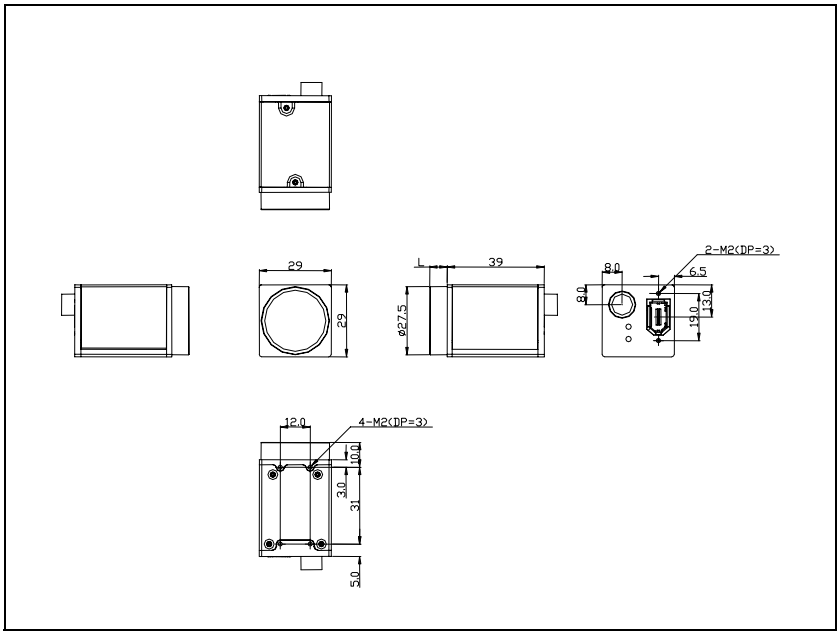
Camera Body Size : 29 (w) x 29 (H) x 39(D) mm

Camera Body Weight : approx. 63 gram

<FOculus T CCD Cameras>



<FOculus T CMOS Cameras>



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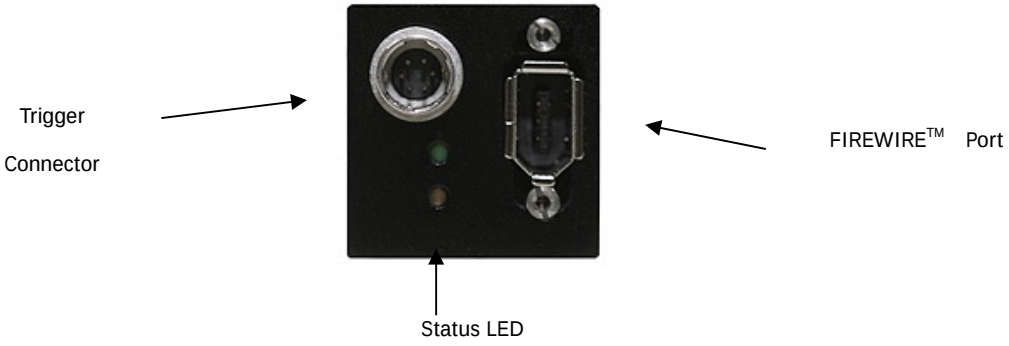
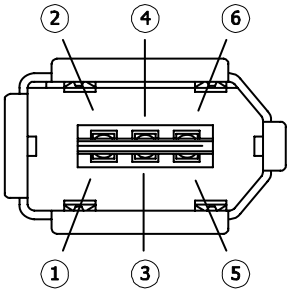
1.5. Camera Interface

FOculus T Series camera interfaces are located on the back of the camera(assuming lens mount is front) as per the follows.



1.6. FIREWIRE Port

The industry standard FIREWIRE™ (IEEE-1394) port has the following pin assign. Data and control on the camera is operated via FIREWIRE™ and camera power can also be supplied by FIREWIRE™

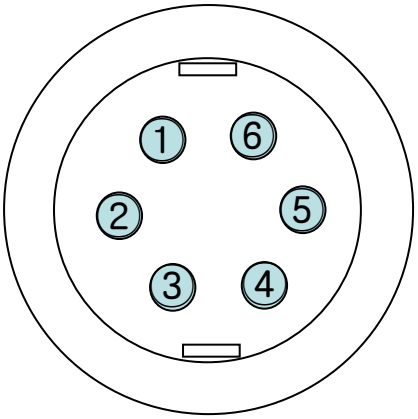


Pin	Signal
1	VP
2	VG(Ground)
3	TPB-
4	TPB+
5	TPA
6	TPA-

CAUTION : DO NOT reverse the polarity which may result in damage to the camera.

1.6.1. Trigger Connector Port

External Trigger Connector provides the access to multiple I/O and also provides power as a secondary source.



<Camera Side>

Pin	I/O	Signal Name
1	O	TX232
2	I	RX232
3	X	NC
4	O	Strobe
5	I	Ext. Trigger
6	I	GND

Remark : NC pins must have no connection

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1.6.2. Status LED

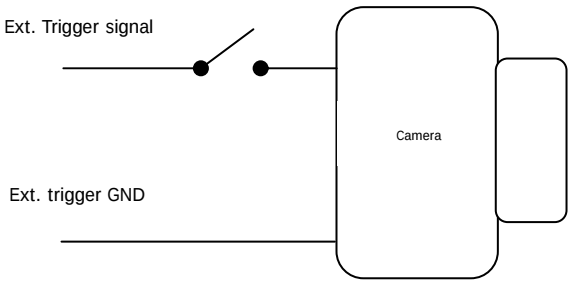
LED Status	Isochronous Channel	Packet Transfer
RED	Disable	NO
GREEN	Enable	YES
OFF	Enable	NO

Remark : Also when power off, LED is OFF

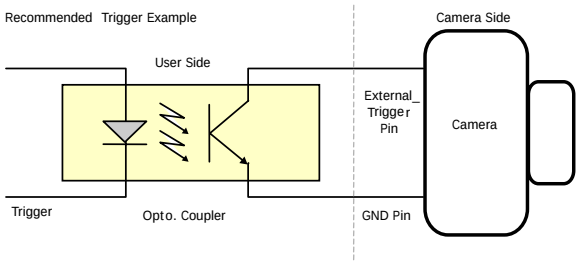
1.7. Electrical Operating Condition

Trigger

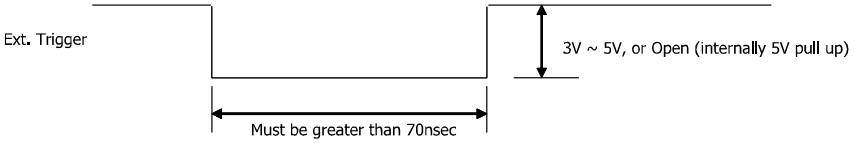
Method1



Method2 [NET GmbH Recommend]



Electrical Specification



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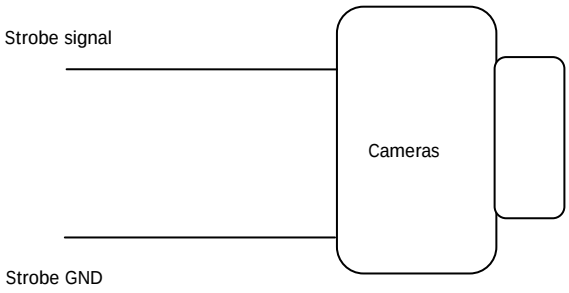
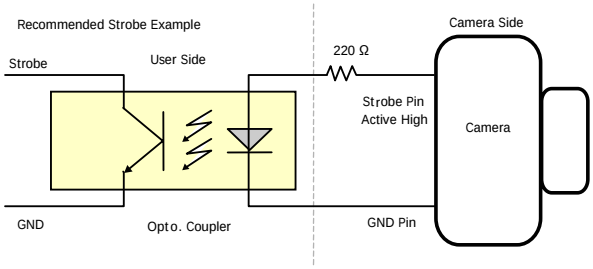
Strobe

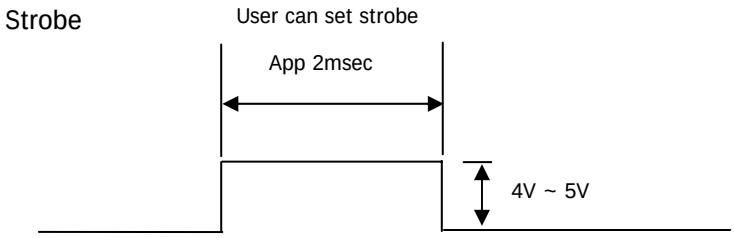
Method1



Method2 [NET GmbH Recommend]



Electrical Specification



1.8. Pixel Data

FOCULUS T SERIES complies with the IIDC 1394-Based Digital Camera Specification V1.31 where data packets are transmitted by FIREWIRE™ interface as isochronous packets. Every video format, mode and frame rate has different video data format. (Pixel data source : IIDC V1.31 Specification)

Isochronous Data Block Packet Format

0 - 7	8 - 15	16 - 23		24 - 31	
Data Length		tg	channel	tCode	Sy
Header CRC					
Video data payload					
Data CRC					

Where the following fields are defined in the IEEE 1394 standard:

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data_length : number of bytes in the data field tg : (tag field) shall be set to zero

channel : isochronous channel number, as programmed in the iso_channel field of the cam_sta_ctrl register

tCode : (transaction code) shall be set to the isochronous data block packet tCode

sy : (synchronization value) shall be set to 0001h on the first isochronous data block of a frame, and shall be set to zero on all other isochronous data blocks

Video data payload : shall contain the digital video information, as defined in the following sections

Video data Payload Structure

Pn : Pixel number / packet .

K : Pn x n (n = 0.....N-1)

(Pn x N = Total pixel number /frame)

<YUV (4: 2: 2) format >

U-(K+0)	Y-(K+0)	V-(K+0)	Y-(K+1)
U-(K+2)	Y-(K+2)	V-(K+2)	Y-(K+3)
U-(K+4)	Y-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-6)	Y-(K+Pn-6)	V-(K+Pn-6)	Y-(K+Pn-5)
U-(K+Pn-4)	Y-(K+Pn-4)	V-(K+Pn-4)	Y-(K+Pn-3)
U-(K+Pn-2)	Y-(K+Pn-2)	V-(K+Pn-2)	Y-(K+Pn-1)

<YUV (4: 1: 1) format >

U-(K+0)	Y-(K+0)	Y-(K+1)	V-(K+0)
Y-(K+2)	Y-(K+3)	U-(K+4)	Y-(K+4)
Y-(K+5)	V-(K+4)	V-(K+4)	Y-(K+5)
U-(K+Pn-8)	Y-(K+Pn-8)	Y-(K+Pn-7)	V-(K+Pn-8)
Y-(K+Pn-6)	Y-(K+Pn-5)	U-(K+Pn-4)	Y-(K+Pn-4)
Y-(K+Pn-3)	V-(K+Pn-4)	Y-(K+Pn-2)	Y-(K+Pn-1)

<Y(Mono) Format >

Y-(K+0)	Y-(K+1)	Y-(K+2)	Y-(K+3)
Y-(K+4)	Y-(K+5)	Y-(K+6)	Y-(K+7)
Y-(K+Pn-8)	Y-(K+Pn-7)	Y-(K+Pn-6)	Y-(K+Pn-5)
Y-(K+Pn-4)	V-(K+Pn-3)	Y-(K+Pn-2)	Y-(K+Pn-1)

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<Y(Mono) Format >

High Byte	Low Byte

Y-(K+0)	Y-(K+1)
Y-(K+2)	Y-(K+3)
Y-(K+Pn-4)	Y-(K+Pn-3)
V-(K+Pn-2)	Y-(K+Pn-1)

Data Structure

<Y, R, G, B >

Each component has 8 bit data. The data type is "Unsigned Char"

	Signal Level (Decimal)	Data (Hexadecimal)
Highest	255	0xFF
	254	0xFE
	.	.
	.	.
	1	0x01
Lowest	0	0x00

<U, V>

Each component has 8 bit data. The data type is "Straight Binary"

	Signal Level (Decimal)	Data (Hexadecimal)
Highest(+)	127	0xFF
	126	0xFE
	.	.
	.	.
	1	0x81
Lowest	0	0x80
	-1	0x7F
	.	.
	.	.
	-127	0x01
Lowest	-128	0x00

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<Y(Mono16)>

Y component has 16 bit data. The data type is “Unsigned Short(big-endian)”

Y	Signal Level (Decimal)	Data (Hexadecimal)
Highest	65535	0xFFFF
	65534	0xFFFE
	.	.
	.	.
	1	0x0001
Lowest	0	0x0000

1.9. Environmental Requirements.

Operation Temperature : -5°C ~ 45°C / Storage Temperature : -20°C ~ 65°C

Avoid operation in environment of high humidity over 90% and allow sufficient airflow for prevention of heat buildup

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2. Basic Installation

FOculus T Series operates in connection with PC or Mac running operation system such as MS Windows, Linux, and Mac OS (Coming Soon). Basic installation starts from driver installation to connecting the camera and loading the demo application software. Please refer to the demo application software manual for details.

2.1. Recommended System Requirement

Requirements	Details and Description
Operating System	Windows 2000(SP4), Windows XP(SP2) or higher
CPU	Intel Pentium 4 1.5 GHz or equivalent AMD CPU or higher
System Memory	256 M Byte or more
Video Adapter	1280 x 1024 with 24 bit color or higher
Hard Disk Drive	40 GB or higher
Optical Drive	CDROM or DVDROM
FIREWIRE™	FIREWIRE™ OHCI PCI or PC-Card Adaptor
Cable	Standard FIREWIRE™ 6P-6P cable or 4P to 6P cable (for Notebooks)
Software	DirectX 9.0 or higher (9.0b or higher for Windows XP) NET GmbH Digital Imaging CD (FOControl Application and Driver) Or other Windows Application such as amcap.exe

Remark : Other software or hardware may be required for user specific applications.

2.2. Hardware Installation

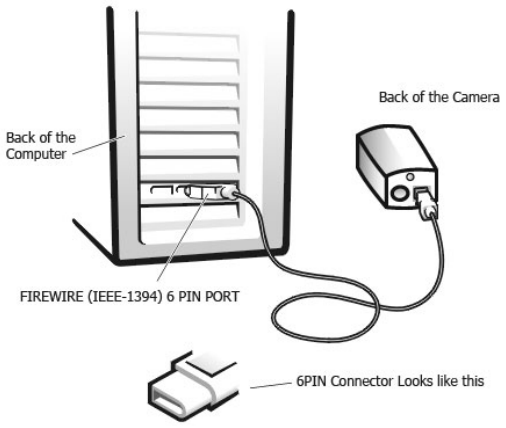
Basic camera installation is a very simple 3 STEP Process as follows. (Also check the figure below)

STEP 1. Turn to the back of the computer and locate the FIREWIRET port.

(Note : some might have FIREWIRET port in the front).

STEP 2. Plug one end of the FIREWIRETE cable to the computer's FFIREWIRET port.

STEP 3. Plug the other end of the FIREWIRET cable to the camera's FIREWIRET port.



Basic Hardware Installation and Camera Connection

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2.3. Software Installation

Important !!, DO NOT CONNECT THE CAMERA before any Installation !!

Insert the NET Digital Imaging CD which would auto install the camera drivers and demo applications. (For details of the application and driver please refer to the demo application manual.)

FIREWIRE™ Digital Imaging CD

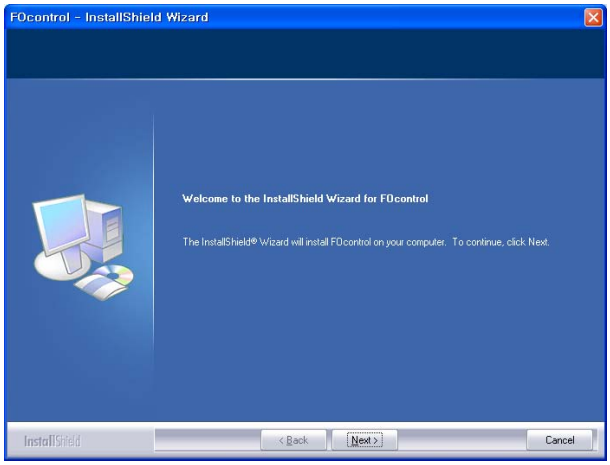
Driver

Demo Software

FOControl API Library

Manuals

2.3.1. Application Installation.


FOcontrol - InstallShield Wizard
Welcome to the InstallShield Wizard for FOcontrol
The InstallShield® Wizard will install FOcontrol on your computer. To continue, click Next.
InstallShield
< Back
Next >
Cancel

Follow the instruction as per the application install dialog by inputting “Name of User” and “Company” and select “Setup type”.

A dialog would appear to disconnect the camera before driver installation.

”PLEASE DISCONNECT THE CAMERA FROM THE COMPUTER”

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FOcontrol - InstallShield Wizard
InstallShield Wizard Complete
The InstallShield Wizard has successfully installed FOcontrol. Click Finish to exit the wizard.
< Back
Finish
Cancel

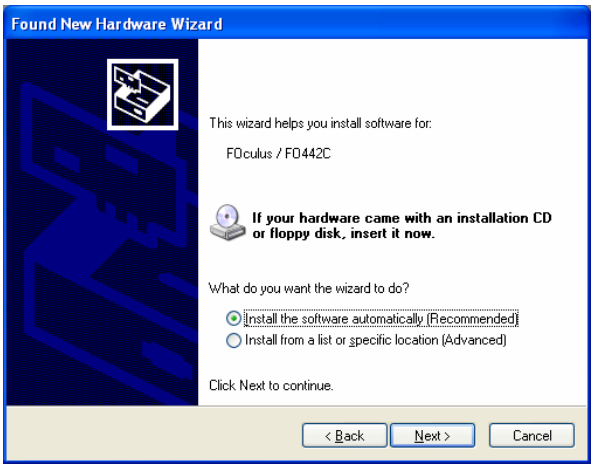
Restart the computer.

2.3.2. Connecting the Camera for driver installation

After the computer restart, connect the camera and follow the following instruction to install the driver.

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel

By Camera plug in, windows would recognize the driver automatically and install the driver.


Found New Hardware Wizard
This wizard helps you install software for:
FOculus / FO442C
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel

Please select

“Install the software automatically”.

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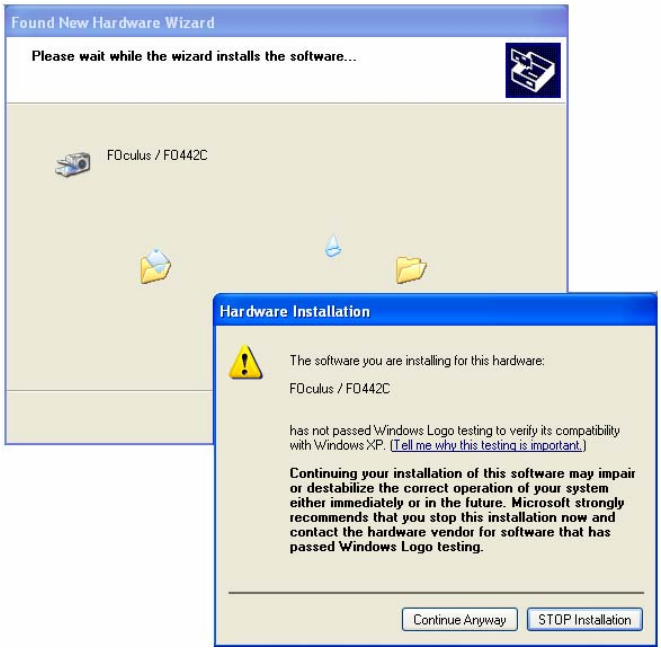
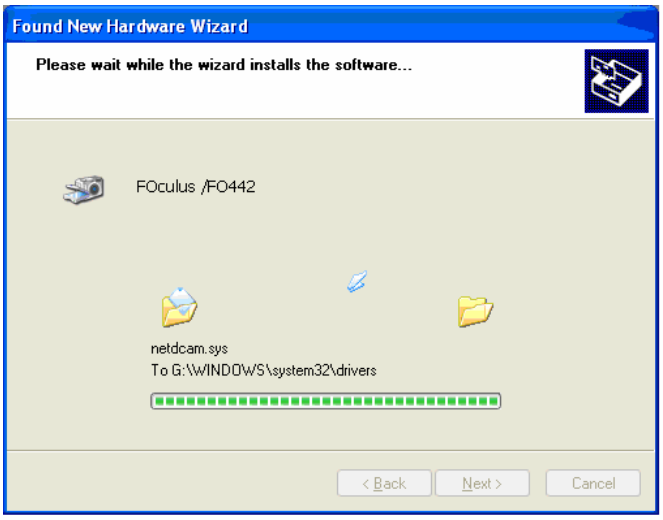
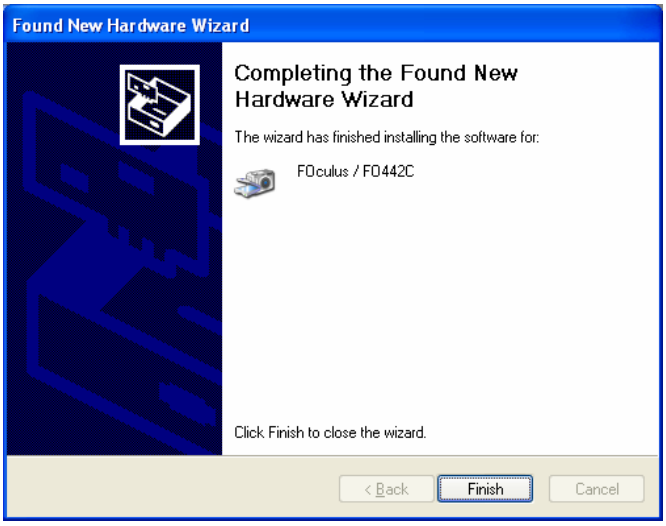

Found New Hardware Wizard
Please wait while the wizard installs the software...
FOculus / FO442C
Hardware Installation
The software you are installing for this hardware:
FOculus / FO442C
has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)
Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
Continue Anyway
STOP Installation

Device Driver installation dialog would appear and please click “Continue Anyway” for driver installation.



Device driver being installed.



Now the camera is connected and Camera Driver is installed.

From now on without installing the application again, the camera would be detected automatically.

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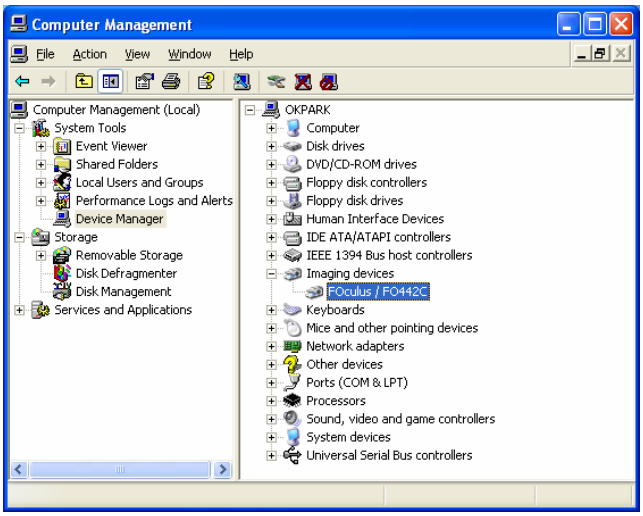
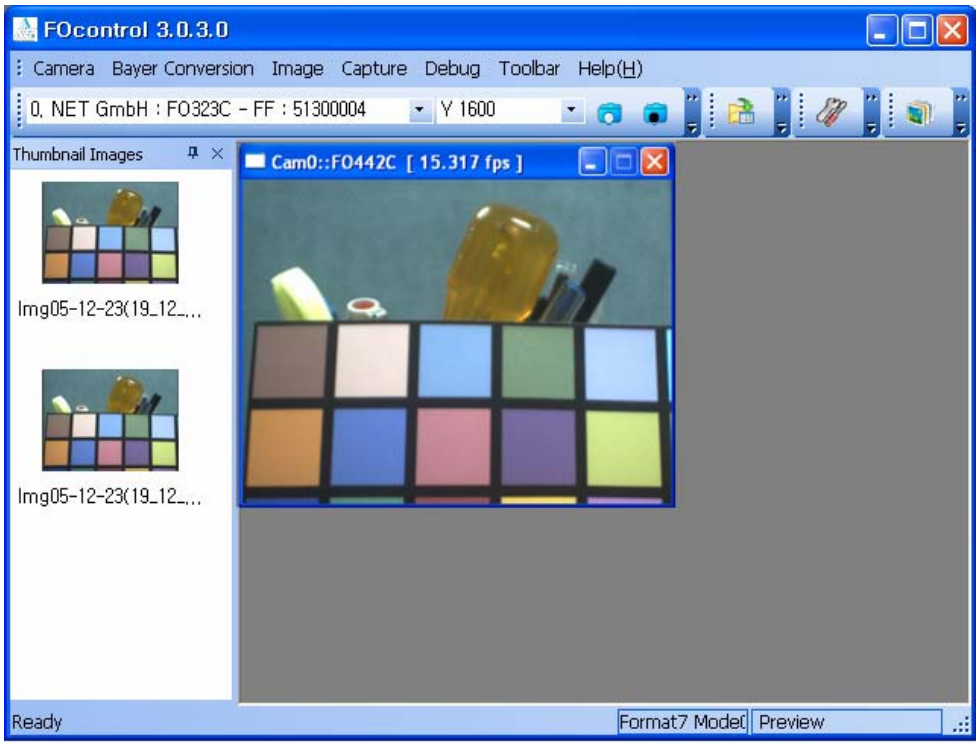
2.3.3. Checking Windows Device Manager for Driver Verification.



Go to “Imaging Device” in Windows Device Manager to check driver install.

Once the driver installation is verified, you are all set to start camera operation

2.3.4. FOControl Application



Once the driver is installed you can start the FOControl Demo Application to check the various feature of the camera.

Please refer to the demo application manual for further features of the demo application and its usage.

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3. FOculus T Series Camera Specifications.

3.1. Black and White Camera

3.1.1. FO531TB Specification

Features (FO531TB)		
Image Sensor Type		1/1.8-inch Interline CCD (Sony ICX274AL)
Effective pixels		2,010,000 pixels 1628(H) x 1236(V)
Picture Size		1600x1200, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		4.4x4.4
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16 16 (1600x1200, Format 7 mode 0) 32 (640x480, Format 7 mode 0) 29 (800x600, Format7 mode 1, 2x2 binning) 29 (1600x600, Format7 mode 2, 1x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14,15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt,
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.1.2. FO432TB Specification

Features (FO432TB)		
Image Sensor Type		1/2-inch Interline CCD (Sony ICX267AL)
Effective pixels		1,450,000 pixels 1388(H) x 1040(V)
Picture Size		1388x1040, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		4.65x4.65
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16 20 (1388x1040, Format 7 mode 0) 35 (1388x520, Format 7 mode 0) 37(688x516, Format 7 mode 1 2x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14,15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt,
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.1.3. FO323TB Specification

Features (FO323TB)		
Image Sensor Type		1/3-inch Interline CCD (ICX204AL)
Effective pixels		800,000 pixels 1034(H) x 779(V)
Picture Size		1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.65x4.65
Real Frame Rate		30, 15, 7.5, 3.75, 1.875 / Y8, Y16 30 (1024x768, Format 7 mode 0) 58 (1024x384, Format7 mode2, 1x2 binning) 58 (512x384, Format7 mode1, 2x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 70us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.1.4. FO124TB Specification

Features (FO124TB)		
Image Sensor		1/3-inch Interline CCD (ICX424AL)
Effective Pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480, 320 x 240
Cell Size		7.40x7.40
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16 60 (640x480, Format 7 mode 0) 120 (640x240, Format7 mode2, 1x2 binning) 120 (320x240, Format7 mode1, 2x2 binning)
Lens Mount		C-mount
Scanning System		Progressive System
Binning		Not support
Format 7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 43us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.1.5. FO1433TB Specification

Features (FO1433TB)		
Image Sensor		1/2" MT9M001 (Micron CMOS)
Effective Pixels		1,310,720 pixels 1280(H) x 1024(V)
Picture Size		1280x1024, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		5.2 x 5.2
Real Frame Rate		60, 30, 15, 7.5, 3.75 / Y8, Y16 24 (1280x1024, Format 7 mode 0)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format 7		Partial Scan (Unit: 4x4)
Trigger	Rising Edge or	Rising Edge or Falling Edge
	Mode	0
	External Trigger	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		Not support
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		Not support
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 70us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		6 ~ 18dB (Manual or Auto)
Shutter Speed		60 usec ~ 500 msec (Manual or Auto)
Data Depth		10 bit
S/N Ratio		45dB or better
Supply Voltage & Power		Less than 2Watts(@12V DC)
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.1.6. FO1224TB Specification

Features (FO1224TB)		
Image Sensor Type		1/3" MT9V022177ATM (Micron CMOS)
Effective pixels		360,960 pixels 752(H) x 480(V)
Picture Size		752x480, 640x480, 376x240
Cell Size(um)		6.0 x 6.0
Real Frame Rate		60, 30, 15, 7.5, 3.75 60(752x480, Format 7 mode 0), 110(376x240, Format 7 mode 1, 2x2binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2 x 2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		Not support
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		Not support
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 70us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 12dB (Manual or Auto)
Shutter Speed		93 usec ~ 100 msec (Manual or Auto)
Data Depth		10 bit
S/N Ratio		45dB or better
Supply Voltage & Power		Less than 2Watts(@12V DC)
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.2. Color Cameras

3.2.1. FO531TC Specification

Features (FO531TC)		
Image Sensor Type		1/1.8-inch Interline CCD (Sony ICX274AQ)
Effective pixels		2,010,000 pixels 1600(H) x 1200(V)
Picture Size		1600x1200, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		4.4x4.4
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 16 (1600x1200, Format 7 mode 0) 32 (640x480, Format 7 mode 0) 29 (800x600, Format7 mode 1, 2x2 binning) 29 (1600x600, Format7 mode 2, 1x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2, 1x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14,15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt,
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.2.2. FO432TC Specification

Features (FO432TC)		
Image Sensor Type		1/2-inch Interline CCD (Sony ICX267AQ)
Effective pixels		1,450,000 pixels 1388(H) x 1036(V)
Picture Size		1388x1036, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		4.65x4.65
Real Frame Rate		15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 20 (1388x1036, Format 7 mode 0) 35 (1388x520, Format 7 mode 0)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14,15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate, AWB
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 106us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 27 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

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3.2.3. FO323TC Specification

Features (FO323TC)		
Image Sensor Type		1/3-inch Interline CCD (ICX204AK)
Effective pixels		800,000 pixels 1034(H) x 779(V)
Picture Size		1024x768, 800x600, 640x480, 320x240
Cell Size(um)		4.65x4.65
Real Frame Rate		30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 30 (1024x768, Format 7 mode 0)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate, AWB
		U/B V/R, Hue/G
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 70us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 25 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		8 bit or 12 bit Raw RGB, YUV4:2:2
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.2.4. FO124TC Specification

Features (FO124TC)		
Image Sensor Type		1/3-inch Interline CCD (ICX424AQ)
Effective pixels		330,000 pixels 659(H) x 494(V)
Picture Size		640 x 480, 320 x 240
Cell Size(um)		7.40x7.40
Real Frame Rate		60, 30, 15, 7.5, 3.75, 1.875 / Y8, Y16, YUV422 60 (640x480, Format 7 mode 0)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		-144 us ~ +144 us at 60,30,15,7.5 frame rate
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		65535 Shots
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate, AWB
		U/B V/R, Hue/G
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 43us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 25 dB (Manual or Auto)
Shutter Speed		1 usec ~ 3600 sec (Manual or Auto)
Data Depth		12 bit
S/N Ratio		56dB or better
Supply Voltage & Power		8 VDC ~ 30 VDC, 280mA 12 V DC
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.2.5. FO1631TC Specification

Features (FO1631TC)		
Image Sensor Type		1/2" MT9T031 (Micron CMOS)
Effective pixels		3,145,728 pixels 2048(H) x 1536(V)
Picture Size		2048x1536, 1600x1200, 1280x960, 1024x768, 800x600, 640x480
Cell Size(um)		3.2 x 3.2
Real Frame Rate		60, 30, 15, 7.5, 3.75 / Y8, Y16, YUV422 10 (2048x1536, Format 7 mode 0) 26 (1024x768, Format 7 mode 1, 2x2 binning)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		2x2
Format7		Partial Scan (Unit: 4x4)
Trigger	Edge	Rising Edge or Falling Edge
	Mode	0
	Source	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		Not support
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		Not support
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate, AWB, U/B V/R, Hue/G
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 43us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mbps
Gain		0 ~ 63 (digital gain) (Manual or Auto)
Shutter Speed		63 usec ~ 1 sec (Manual or Auto)
Data Depth		8 bit or 10 bit Raw RGB, YUV4:2:2
S/N Ratio		43dB or better
Supply Voltage & Power		Less than 2Watts(@12V DC)
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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3.2.6. FO1224TC Specification

Features (FO1224TC)		
Image Sensor		1/3" MT9V022177ATC (Micron CMOS)
Effective Pixels		360,960 pixels 752(H) x 480(V)
Picture Size		752x480, 752X476, 640x480
Cell Size		6.0 x 6.0
Real Frame Rate		60, 30, 15, 7.5, 3.75 / Y8, Y16, YUV422 60 (752x480, Format 7 mode 0) 60 (752x476, Format 7 mode 2, yuv422)
Lens Mount		C Mount
Scanning System		Progressive System
Binning		Not support
Format 7		Partial Scan (Unit: 4x4)
Trigger	Rising Edge or	Rising Edge or Falling Edge
	Mode	0
	External Trigger	External Trigger or Software Trigger
Strobe		Active High, Support Normal Mode or Trigger Mode.
Multi-camera auto sync		Not support
Memory Save/Load		16 Channels(0:factory, 1~4:feature, 5~15:mode/feature)
One-shot/Multi-shot		Not support
Control Functions		Brightness, Sharpness, Gamma, Auto-Exposure, Auto-Shutter, Pan/Tilt, High speed up trigger frame rate, AWB, U/B V/R, Hue/G
SIO(RS-232)		IIDC v1.31 version : Path through or NET Command
Frame Delay from Read-out		Min. 70us
Digital Interface / Transfer Rate		IEEE 1394 1 port(6pin) / 400Mpbs
Gain		0 ~ 12dB (Manual or Auto)
Shutter Speed		93 usec ~ 100 msec (Manual or Auto)
Data Depth		8 bit or 10 bit Raw RGB, YUV4:2:2
S/N Ratio		45dB or better
Supply Voltage & Power		Less than 2Watts(@12V DC)
External Dimension / Weight		29(W) x 29(H) x 39(D) mm / Approx 63g
Operation Temp.		-5°C to 45°C

Remark : Camera Specification described above may be changed without notice

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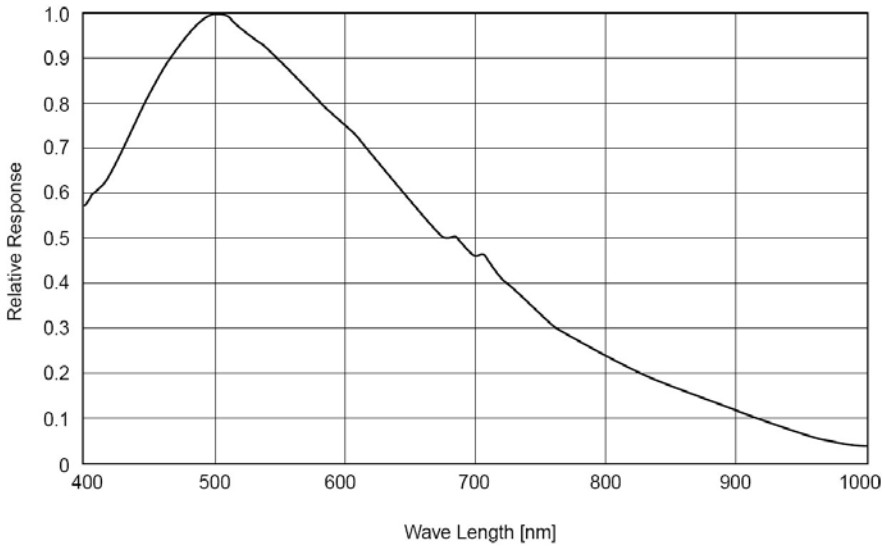
3.3. Spectral Sensitivity

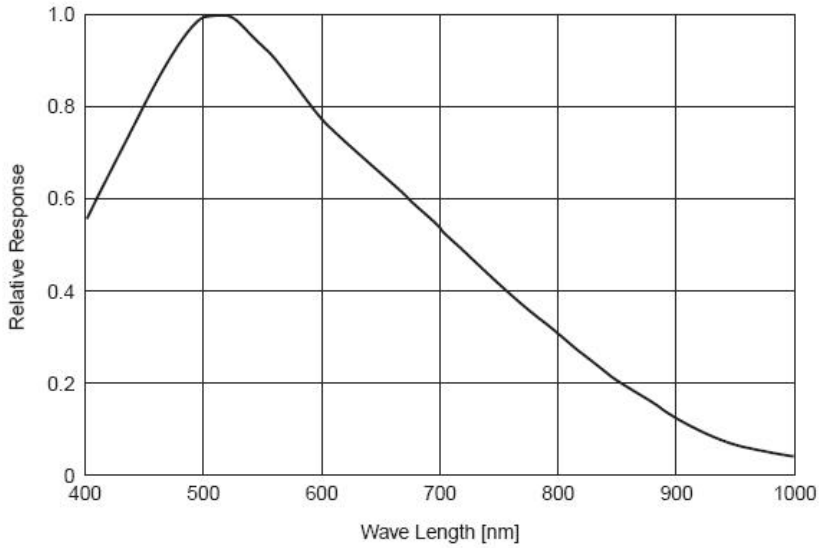
Excludes lens and light source characteristic

3.3.1. FOculus T Series B&W Cameras

<CCD sensors>



Spectral Sensitivity for FO531TB



Spectral Sensitivity for FO432TB

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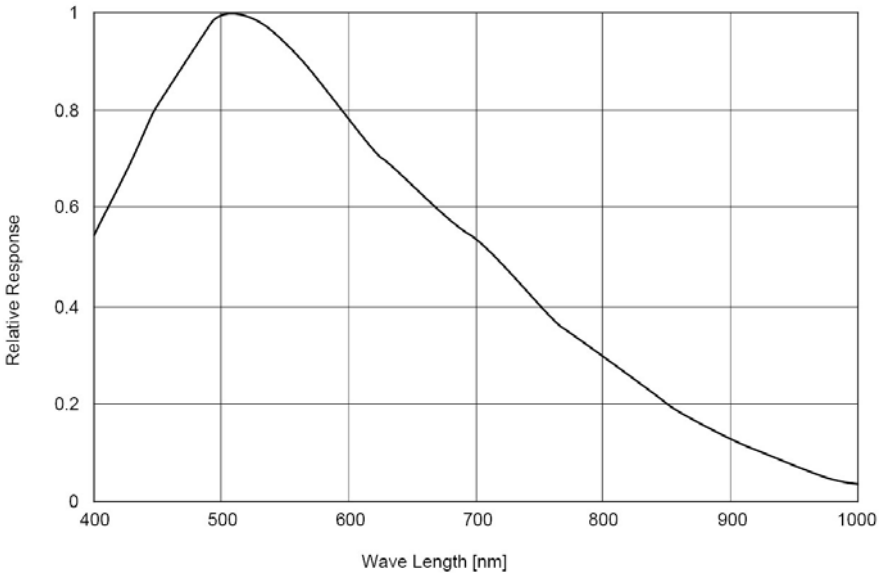
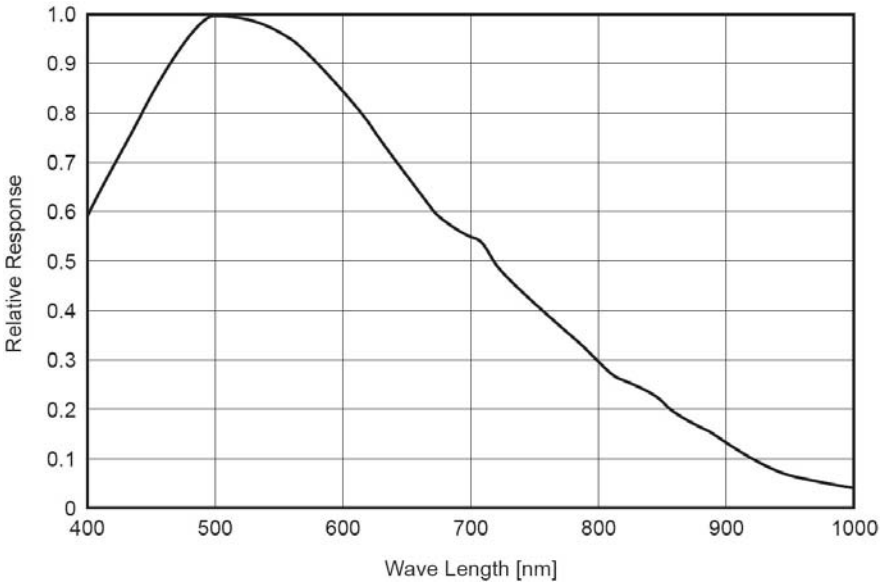


Spectral Sensitivity for FO323TB



Spectral Sensitivity for FO124TB

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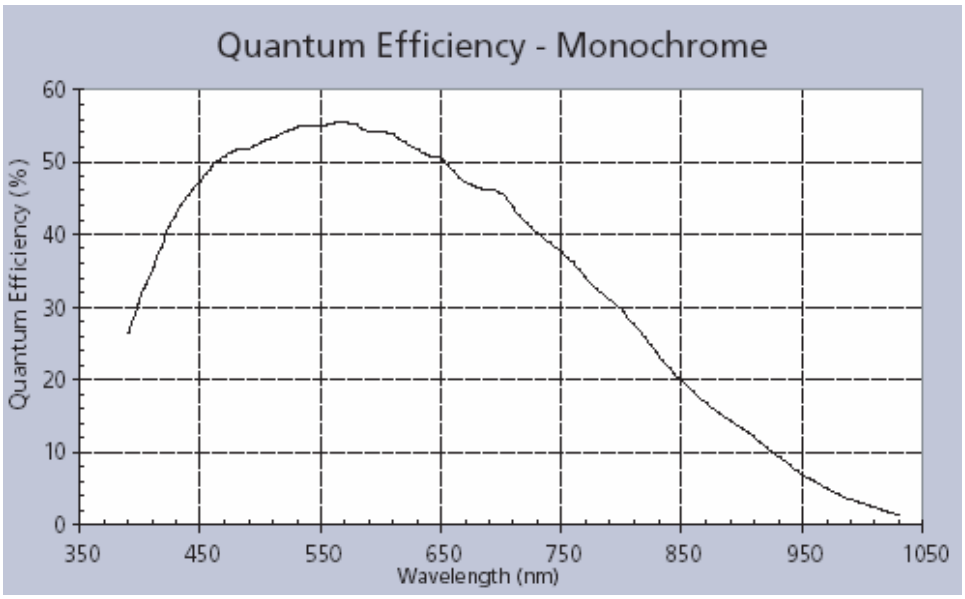
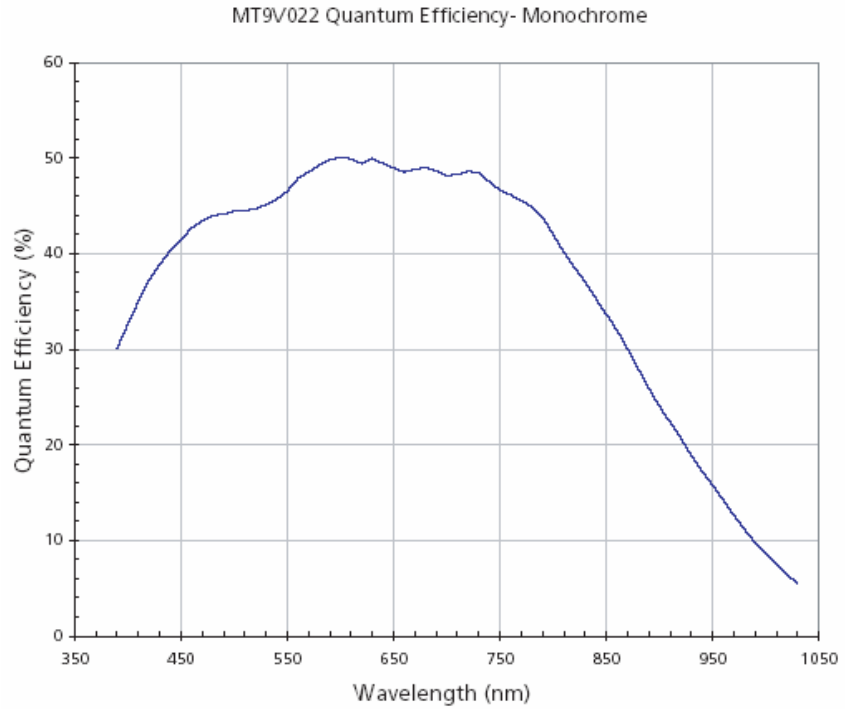
<CMOS sensors>



Spectral Sensitivity for FO1433TB



Spectral Sensitivity for FO1224TB

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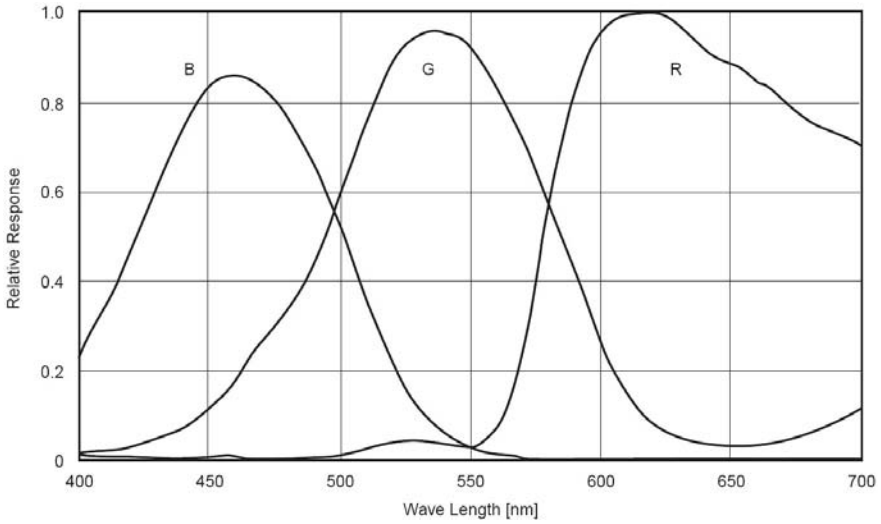
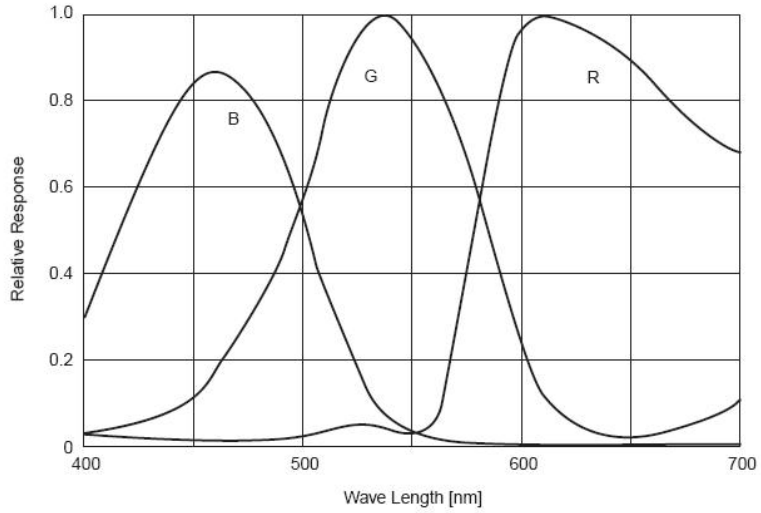
3.3.2. FOculus T Series Color Cameras

<CCD Sensors>



Spectral Sensitivity for FO531TC



Spectral Sensitivity for FO432TC

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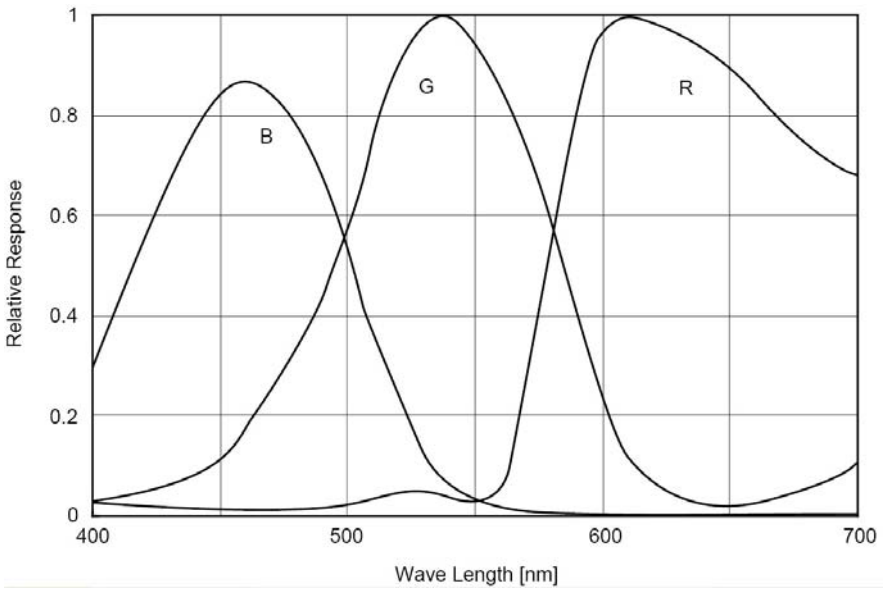
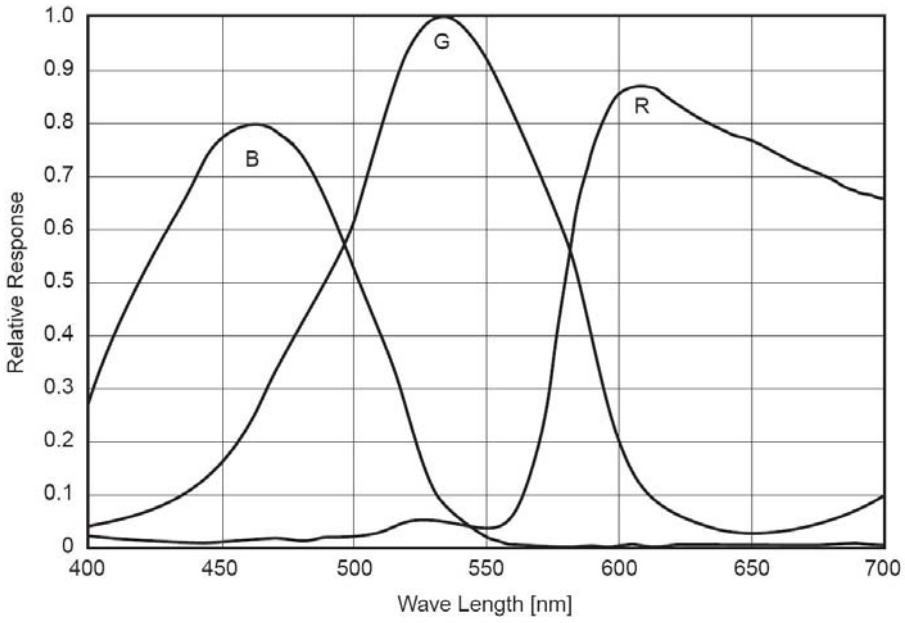


Spectral Sensitivity for FO323TC



Spectral Sensitivity for FO124TC

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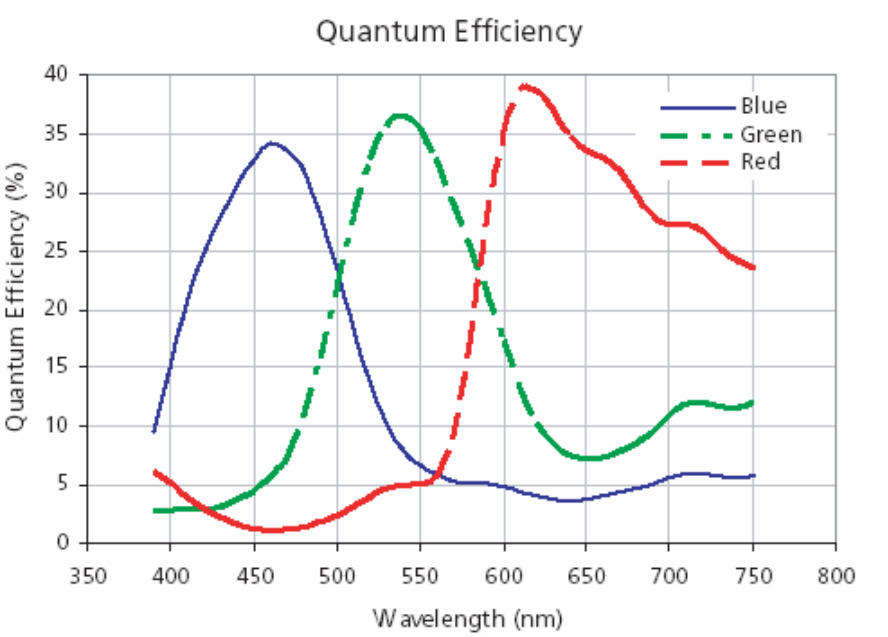
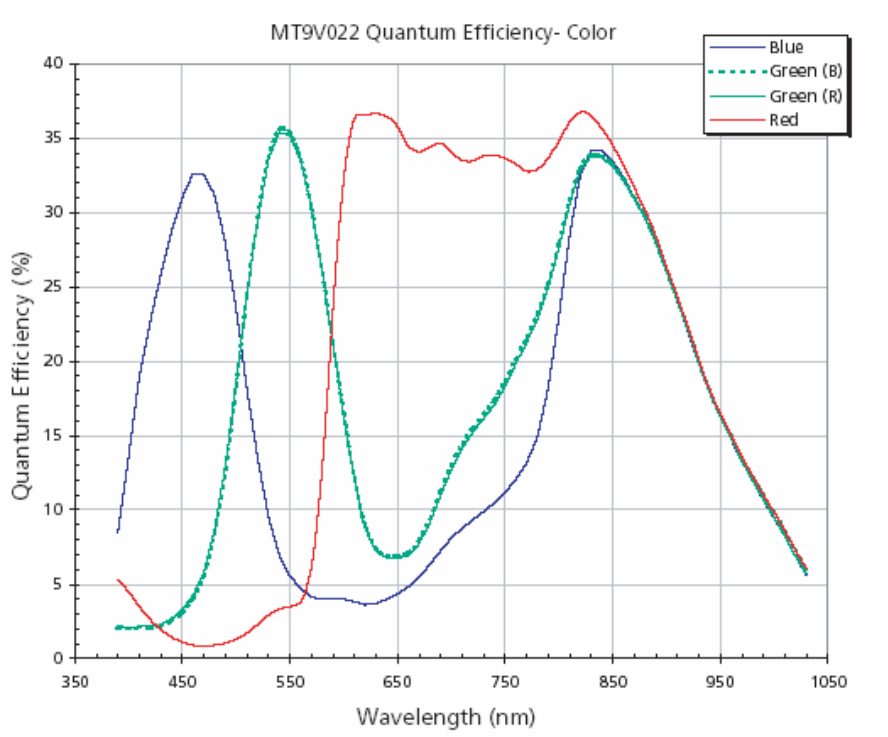
<CMOS sensors>



Spectral Sensitivity for FO1631TC



Spectral Sensitivity for FO1224TC

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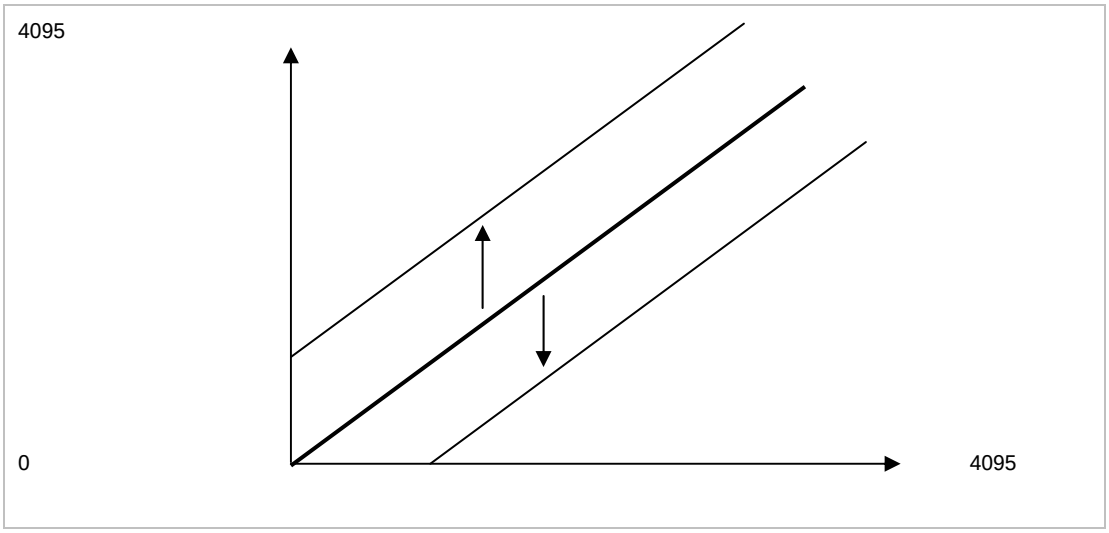
4. Basic Operation and Features

FOculus T Series employ progressive scan CCD sensor which provides features according to each model. Basic functions and features are similar while each camera of it's range would have their specific function support. FOculus T Series fully support the IIDC V1.31 specification such as registers, video format, mode of operation and control.

4.1. Brightness

Brightness of the camera can be controlled by changing the black level in the camera User can inquire the setting of the camera and control using the status control register. Adjust the brightness if the appropriate gradation cannot be obtained due to blurring of black portion of the image. The parameters of Brightness are changed in camera side. For brightness, its parameters are shifted by the black level.



Inquiry Register

Address	Name	Field	Bit	Description
500h	BRIGHTNESS_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description

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800h	BRIGHTNESS	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..4]	Reserved
		One_Push	[5]	Write '1': begin to work(Self cleared after operation) Read : Value='1' in operation Value ='0' not in operation If A_M_Mode=1, this bit is ignored
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status 0: OFF, 1:ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write : Set the mode Read : Read a current mode 0: Manual, 1:Auto
		-	[8..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

4.2. Auto Exposure Control

The automatic shutter/gain mode is based on a feedback loop which calculates the average pixel luminance. Then the average is compared with the exposure reference value, adjusting shutter and gain accordingly. This feature is similar to "Contrast Control"

Inquiry Register

Address	Name	Field	Bit	Description
504h	AUTO_EXP OSURE_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode(Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Auto_Inq	[6]	Auto mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode(Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
804h	AUTO_EXP OSURE	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..4]	Reserved

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		One_Push	[5]	Write '1' :begin to work (Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0:OFF, 1:ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1:Auto
		-	[8..19]	Reserved
		Value	[20..31]	Value : Write the value in Auto mode, this filed is ignored. If "ReadOut" capability is not available, read value Has no meaning

4.3. Sharpness

The sharpness control feature may be used to compensate low-pass effects caused for instance by the special color interpolation. If you do not prefer such signal manipulation, you may switch it OFF. For sharpness control inquiry and status register, follow the same definition as "BRIGHTNESS". The function of Edge enhancement described in Chapter5, Advanced Features, is recommended.

4.4. White Balance

Color models have the white balance feature which can be controlled automatically or manually. U/R(Red/Green) and V/B(Green/Blue) alter the degree to which Red and Blue CCD component pixels are weighed to form composite pixels. In manual mode you can adjust the white balance by altering the Blue(U/V) and Red Value(V/R).. One push white balance option can be used for a non-interactive calibration in addition. Currently automatic white balance features are not supported.

Inquiry Register

Address	Name	Field	Bit	Description
50Ch	WHITE_BAL _INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode(Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Auto_Inq	[6]	Auto mode(Controlled automatically by camera)
		Manual_Inq	[7]	Manual mode(Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control

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		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
80Ch	WHITE_BALANCE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..4]	Reserved
		One_Push	[5]	Write '1' :begin to work(Self cleared after operation) Read: Value='1' in operation Value='0' not in operation If A_M_Mode =1, this bit is ignored
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0:OFF, 1:ON If this bit=0, other fields will be read only.
		A_M_Mode	[7]	Write: set the mode, Read: read a current mode 0: Manual, 1:Auto
		-	[8..19]	U Value / B_Value. Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available,, read value has no mean
		Value	[20..31]	V Value / R_Value Write the value in AUTO mode, this field is ignored. If "ReadOut" capability is not available, read value has no meaning

4.5. Hue

Color models support Hue control which changes the color phase of the picture by adjusting the Green gain. You may use this feature when white balance correction adjusting Red and Blue value does give satisfying result.

4.6. Gamma

Gamma control defines the function between incoming light level and output picture level. Factory default setting for Gamma is set to 1.0. Gamma value is adjustable in the range of 0.4 ~ 2.5 as per the table below. For Gamma control inquiry and status register, follow the same definition as "BRIGHTNESS"

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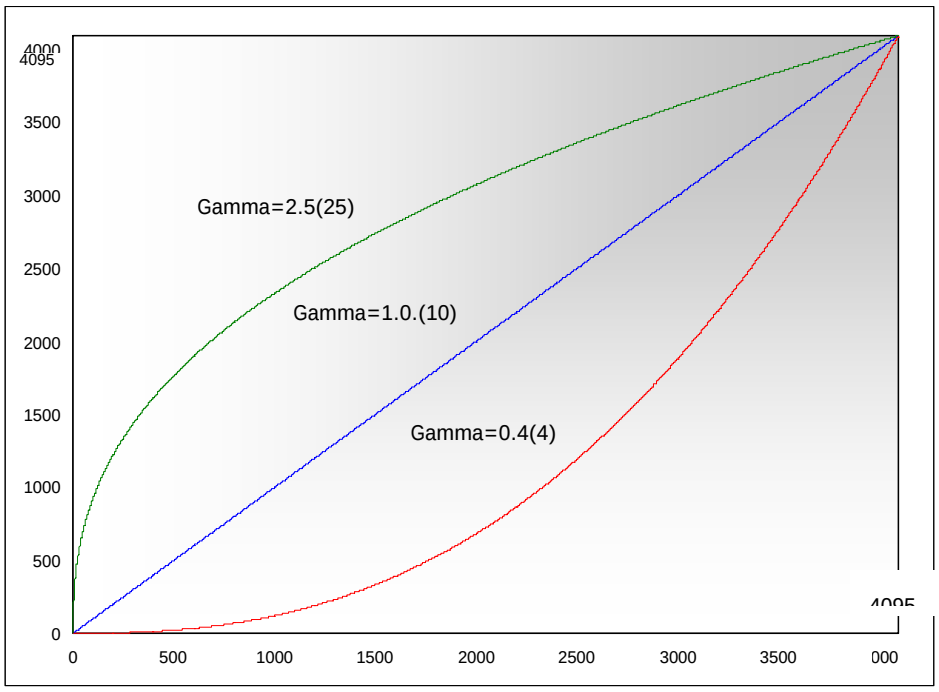

Gamma Range Table

Gamma Value	4	5	6	7	8	9	10	11	12	13	14
Gamma	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4

Gamma Value	15	16	17	18	19	20	21	22	23	24	25
Gamma	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5

4.7. Shutter

Shutter is defined as integration time of the incoming light where both Manual and Auto Shutter is supported. The shutter range varies depending on models. For Shutter control inquiry and status register, follow the same definition as “BRIGHTNESS”

4.7.1. FOculus T CCD Series

Shutter Speed Value & Range

1394 Shutter Value (Y)	Increment Step	Shutter Speed Time : T	
		Exposure Time	Range

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1~500	1us	T= Y us	1us ~ 500us
501~1000	10us	T= (Y-500)*10+500 us	510us ~ 5500us
1001~1705	100us	T= (Y-1000)*100+5500 us	5.6ms ~ 76ms
1706 ~ 2399	1ms	T= (Y-1705)+76 ms	77ms ~ 770ms
2400~2902	10ms	T= (Y-2399)*10+770 ms	780ms ~ 5800ms
2903~3304	100ms	T= (Y-2902)*100+5800 ms	5.9s ~ 46s
3305~3508	1s	T= (Y-3304)*1000+46000 ms	47s ~ 250s
3509~3843	10s	T= (Y-3508)*10 + 250 s	260s ~ 3600s

Shutter Speed Example

Example Shutter Speed Table					
1394 Shutter	Exposure Time	1394 Shutter	Exposure Time	1394 Shutter	Exposure Time
1	1us	1729	100ms	3378	2 min
10	10us	1829	200ms	3438	3 min
100	100us	2129	500ms	3513	5 min
500	500us	2422	1s	3525	7min
550	1ms	2522	2s	3543	10 min
650	2ms	2822	5s	3603	20 min
950	5ms	2944	10s	3663	30 min
1045	10ms	3044	20s	3723	40 min
1145	20ms	3318	60s	3783	50 min
1445	50ms	3323	65s	3843	60 min

4.7.2. FOculus T CMOS Series

Shutter Speed Value & Range

FIREWIRE Shutter Value(Y)	Increment Step	Shutter Speed Time : T	
		Exposure Time	Range
1 ~ 500	1 us	T= Y us	1us ~ 500us
501 ~ 1000	10 us	T= (Y-500)*10+500 us	510us ~ 5500us
1001 ~ 1705	100 us	T= (Y-1000)*100+5500 us	5.6ms ~ 76ms
1706 ~ 2399	1 ms	T= (Y-1705)+76 ms	77ms ~ 770ms
2400 ~ 2422	10 ms	T= (Y-2399)*10+770 ms	780ms ~ 1000ms

Shutter Speed Example

Shutter Speed Example Table			
1394 Shutter	Exposure Time	1394 Shutter	Exposure Time
1	1us	1729	100ms
10	10us	1829	200ms
100	100us	2129	500ms
500	500us	2422	1s

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4.8. Gain

Gain refers to the amount of the CCD output signal amplification where gain and shutter have similar effect to the image. Manual and Automatic gain mode are supported and manual adjustment is possible for the following range. For Gain control inquiry and status register, follow the same definition as “BRIGHTNESS”

4.8.1. FOculus T CCD Series

Camera Type	Step Range	Range in dB	Increment Length
Monochrome Camera	0 ~ 723	0 ~ 27	approx. 0.0345 dB/step
Color Camera	0 ~ 723	0 ~ 25	approx. 0.0319 dB/step
Auto Gain	0 ~ 528	All models except FO124Tx	
Auto Gain	0 ~ 468	FO124Tx	

4.8.2. FOculus T CMOS Series

Camera Type	Step Range	Range in dB	Increment Length
FO1224TB FO1224TC	16 ~ 64	0 ~ 12	(16~31) – 20 x Log(step x 0.0625) (32~64) – 20 x Log(step/2 x 0.0625)
FO1433TB	16 ~ 64	6 ~ 18	20 x Log(step x 0.125)
FO1631TC	0 ~ 63	Digital gain	

4.9. Trigger & Strobe

FOculus T Series support external trigger by receiving input through the external trigger port The falling edge and rising edge can be detected as trigger according to the modes it supports as per the following table. Strobe timing is user controllable while signal output is TTL. FOculus T Series can also be used with a software trigger that issues trigger signal via software command.

4.9.1. Supported Trigger

4.9.1.1. FOculus T CCD Series

Trigger	Edge	Rising Edge or Falling Edge
	Mode	0, 1, 2, 3, 4, 5, 14, 15
	Source	External or Software Trigger

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4.9.1.2. FOculus T CMOS Series

Trigger	Edge	Rising Edge or Falling Edge
	Mode	0
	Source	External or Software Trigger

Inquiry Register

Address	Name	Field	Bit	Description
530h	TRIGGER_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2..3]	Reserved
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this feature On and OFF
		Polarity_Inq	[6]	Capability of changing polarity of trigger input
			[7..15]	Reserved
		Trigger_Mode0_Inq	[16]	Presence of Trigger Mode0
		Trigger_Mode1_Inq	[17]	Presence of Trigger Mode1
		Trigger_Mode2_Inq	[18]	Presence of Trigger Mode2
		Trigger_Mode3_Inq	[19]	Presence of Trigger Mode3
			[20..31]	Reserved

Status Control Register

Address	Name	Field	Bit	Description
830h	TRIGGER_MODE	Presence_Inq	0	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..5]	Reserved
		ON_OFF	[6]	Write: ON or OFF this feature Read: read a status 0: OFF, 1: ON If this bit=0, other fields will be read only.
		Trigger_Polarity	[7]	If Polarity_Inq is “1”, Write to change polarity of the trigger input Read to get polarity of trigger input If Polarity_Inq is “0”, Read only. (0: Low active input, 1: High active input)
			[8..11]	Reserved
		Trigger_Mode	[12..15]	Trigger mode.(Trigger_Mode_0-15)
			[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required.

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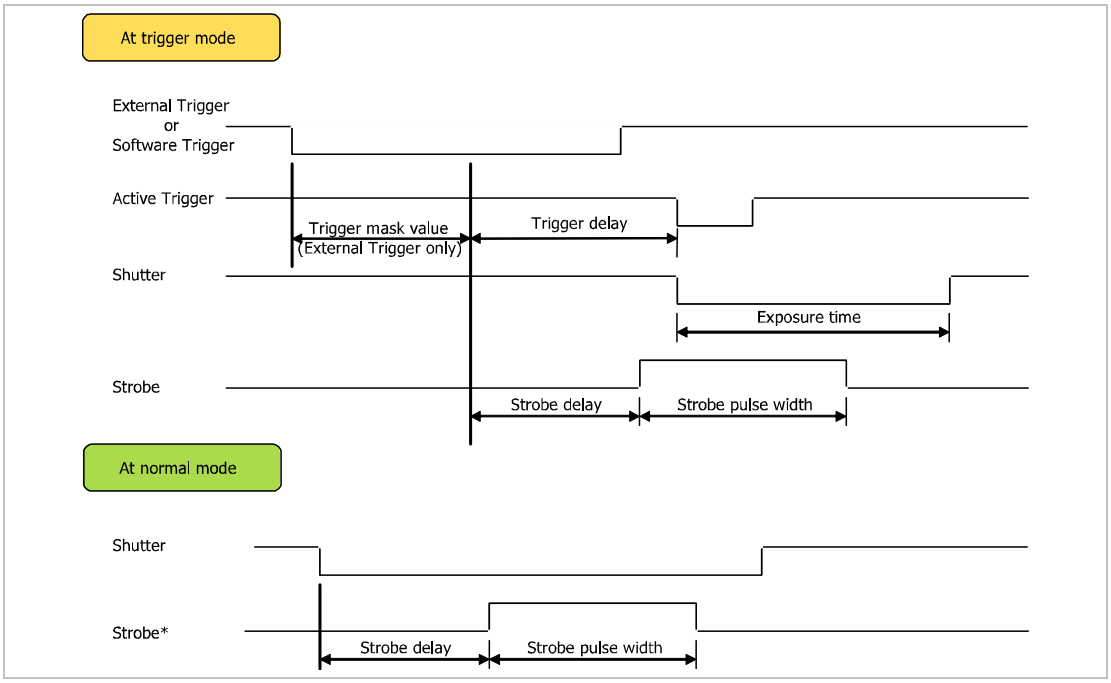
4.9.2. Trigger and Strobe Signal Relation

4.9.2.1. FOculus T CCD Series



Trigger overlapping function : max trigger frame rate speed up to normal mode frame rate.

Previous version

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

Version 3.10

At trigger mode 0 :

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)} + 200\ \text{usec}}$$

If trigger delay = 0 and trigger noise filer is disabled, trigger max frame rate speeds up to frame rate at normal mode

Caution:

If the next trigger pulse interval is less than (1/fps + trigger_delay(0xf0f00834)+trigger_noise_filter(0xf2f10110) + 200 usec), this trigger pulse may be lost.

At other trigger mode : equal to the previous frame rate.

$$\text{Trigger max frame rate} = \frac{1}{1/\text{fps} + \textbf{shutter\_time(0xf0f0081c)} + \text{trigger\_delay(0xf0f00834)} + \text{trigger\_noise\_filter(0xf2f10110)}}$$

If trigger interval is less than (1/fps + shutter_time), bar noise may be detected.

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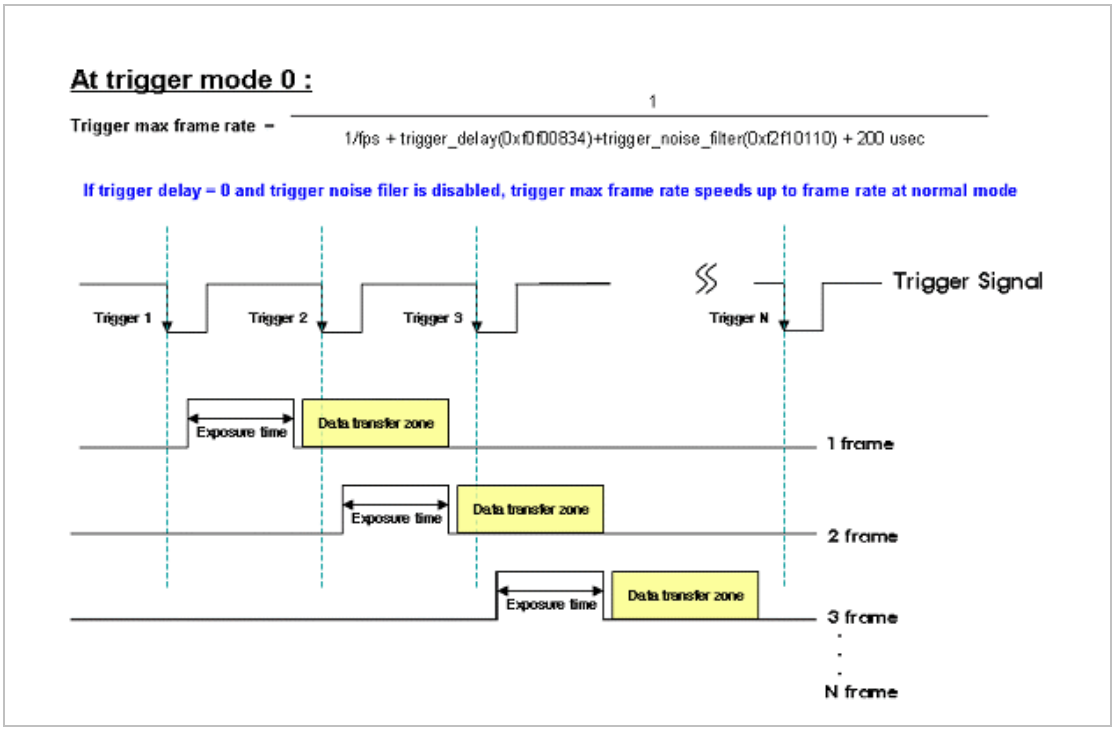
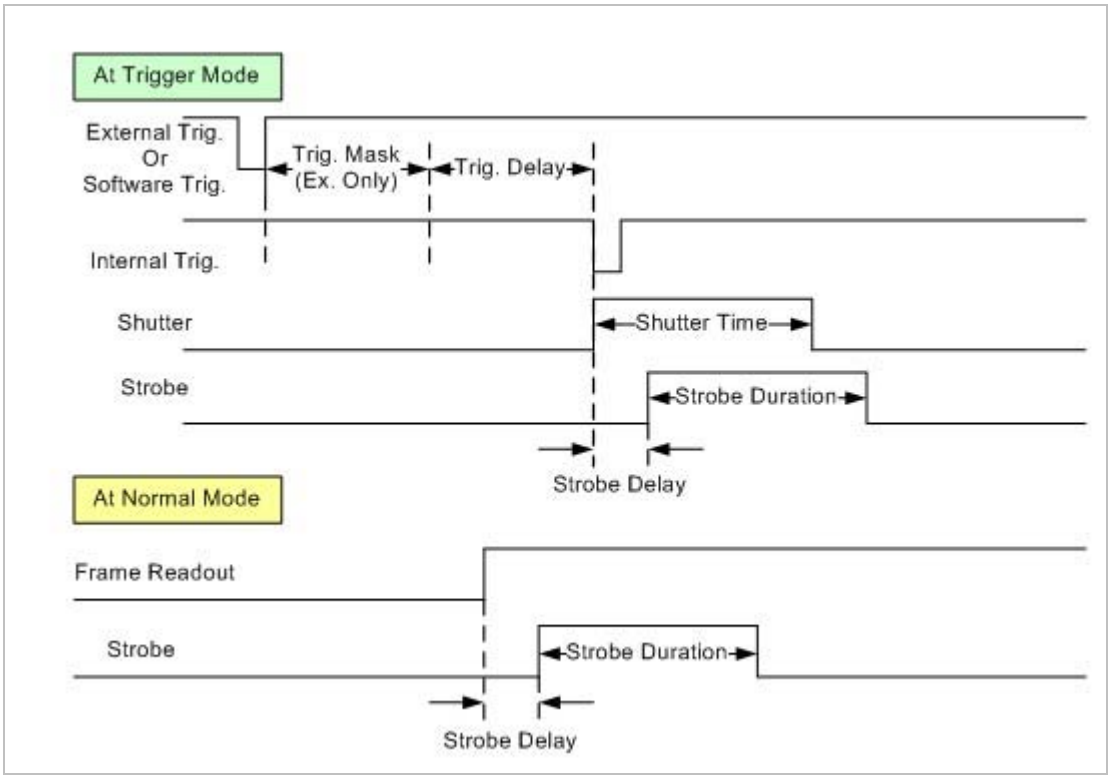


4.9.2.2. FOculus T CMOS Series



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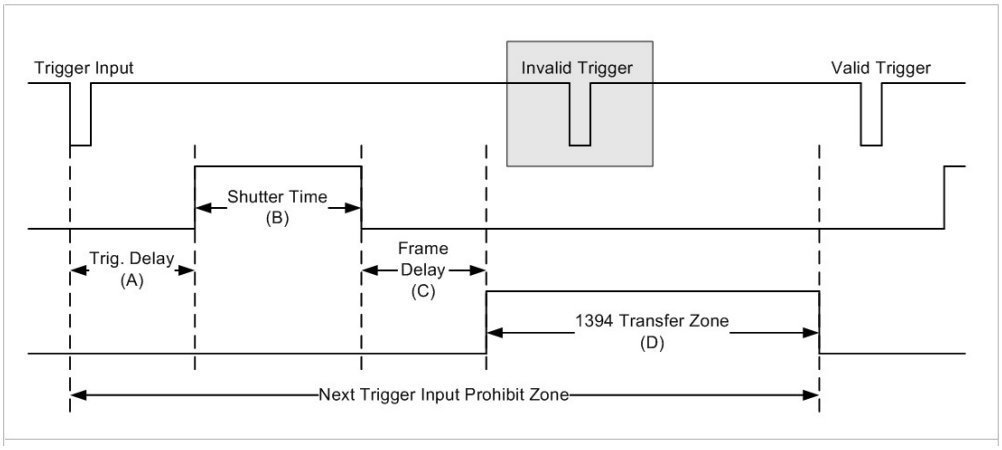
4.9.2.3. Trigger Timing Diagram for FOculus T CMOS Series



Correlation of VD and fps

Cameras	A	B	C	D (Y8)		
FO1224TB FO1224TC	Trigger Mask + Trigger delay + 350ns	Exposure Time	7 HD	640 x 480	60fps	1 VD
					30fps	2 VD
					15fps	4 VD
					7.5fps	8 VD
					3.75fps	16 VD
				752 x 480	Format 7	1VD
FO1433TB	Trigger Mask + Trigger delay + 250ns	Exposure Time	20 HD	640 x 480	60fps	1 VD
					30fps	2 VD
					15fps	4 VD
					7.5fps	8 VD
					3.75fps	16 VD
				800 x 600 1024 x 768	30fps	1 VD
					15fps	2 VD
					7.5fps	4 VD
					3.75fps	8 VD
				1280 x 960	15fps	1 VD
					7.5fps	2 VD
					3.75fps	4 VD
				1280 x 1024	Format 7	1VD
FO1631TC	Trigger Mask + Trigger delay + 250ns	Exposure Time	29 HD	640 x 480	60fps	1 VD
					30fps	2 VD
					15fps	4 VD
					7.5fps	8 VD
					3.75fps	16 VD
				800 x 600	30fps	1 VD
					15fps	2 VD
					7.5fps	4 VD
					3.75fps	8 VD
				1024 x 768 1280 x 960 1600 x 1200	15fps	1 VD
					7.5fps	2 VD
					3.75fps	4 VD
				2048 x 1536	Format 7	1VD

(Y16, YUV422 → D = D x 2)

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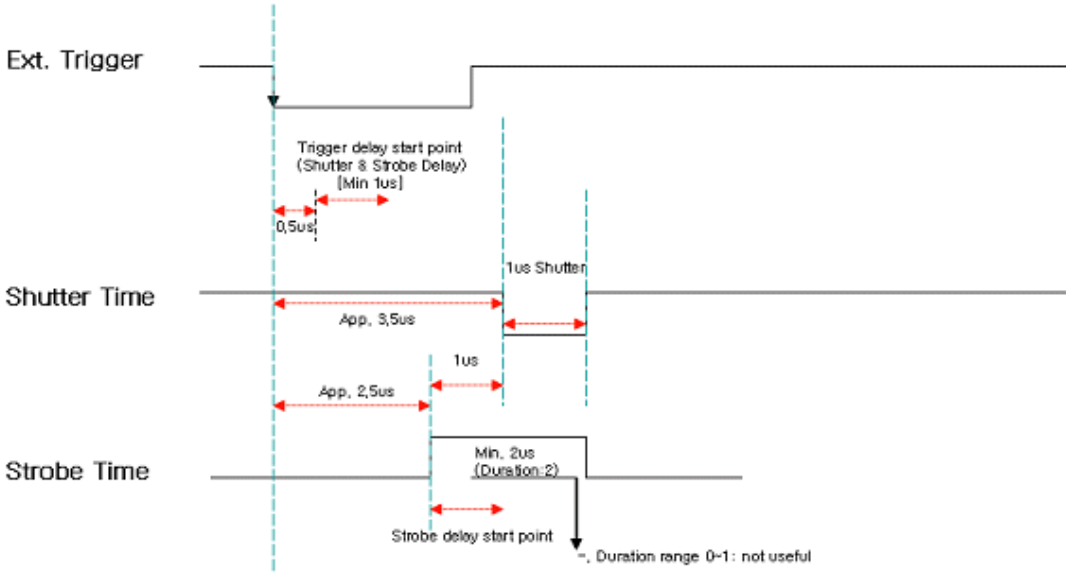
4.9.3. Timing Diagram for External Trigger and Shutter and Strobe

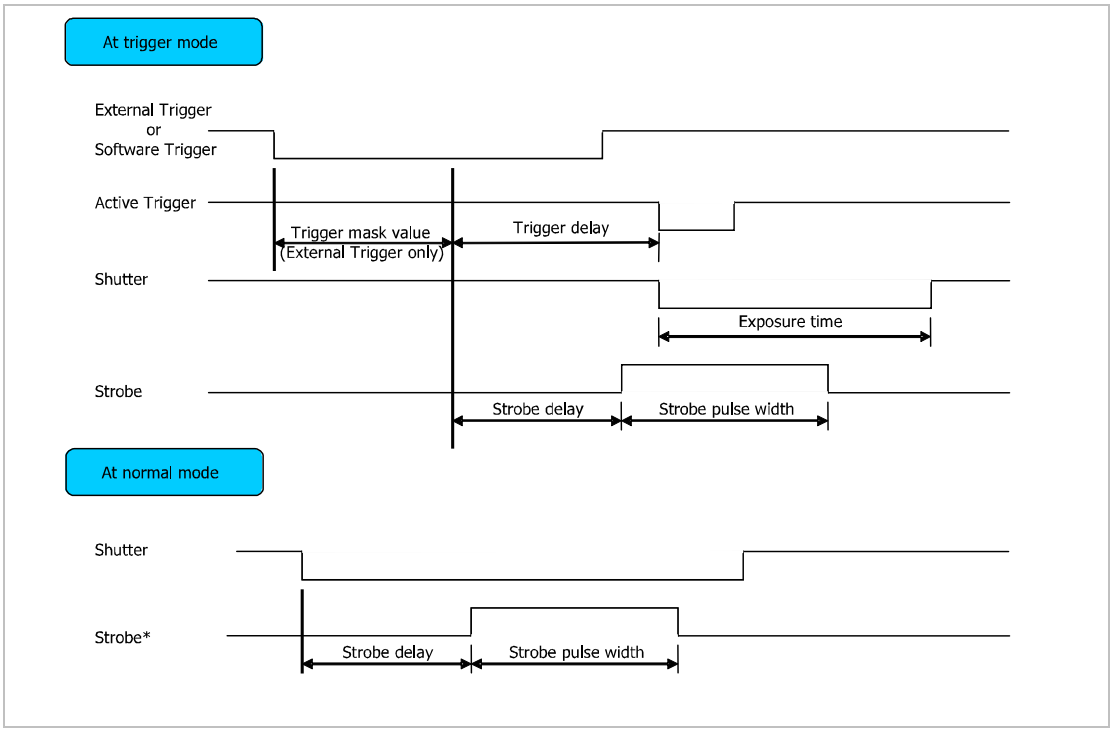
4.9.3.1. FOculus T CCD Series

This diagram shows the necessary time related to each signal for External trigger and Shutter and Strobe.



4.9.4. Trigger & Strobe delay

FOculus T CCD Series / FOculus T CMOS Series



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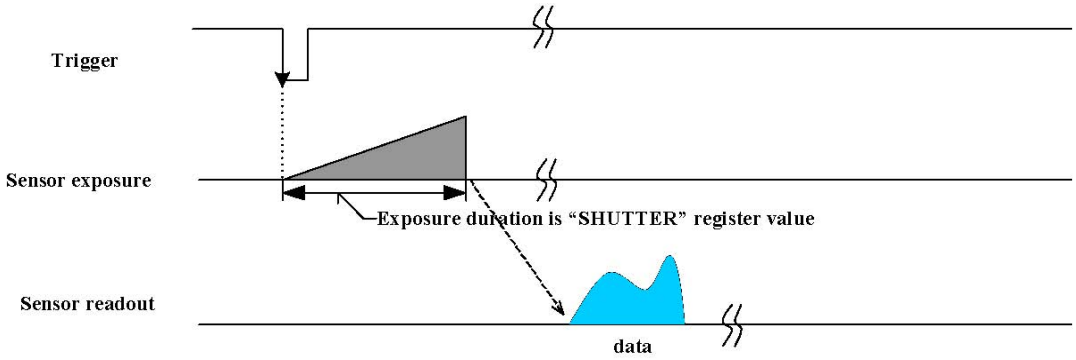
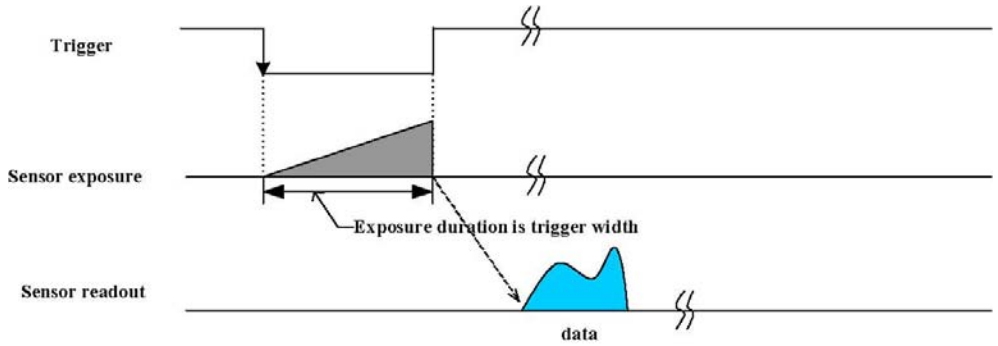
4.9.5. Trigger Mode 0

Camera starts integration of the incoming light from external trigger input falling edge. Integration time is described in "Shutter" register. No parameter is needed.



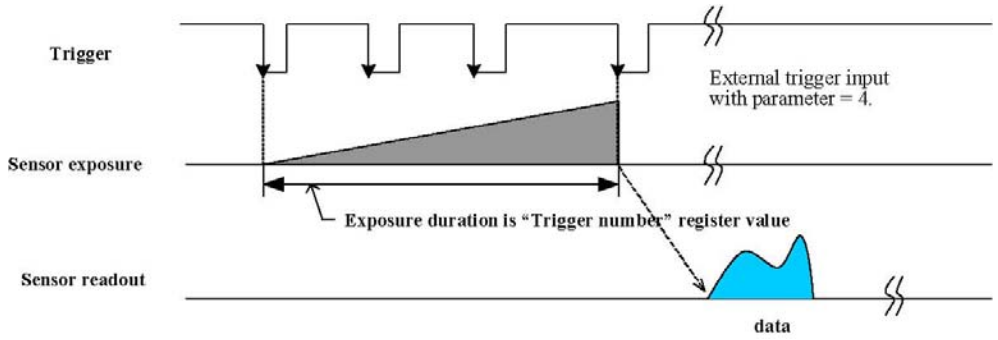
4.9.6. Trigger Mode 1

Camera starts integration of the incoming light from external trigger input falling edge. Integration time is equal to low state time of the external trigger input. No parameter is needed.



4.9.7. Trigger Mode 2

Camera starts integration of incoming light from first external trigger input falling edge. At the N-th (parameter) external trigger input falling edge, integration will be stopped. Parameter is required and shall be two or more. (N >= 2)



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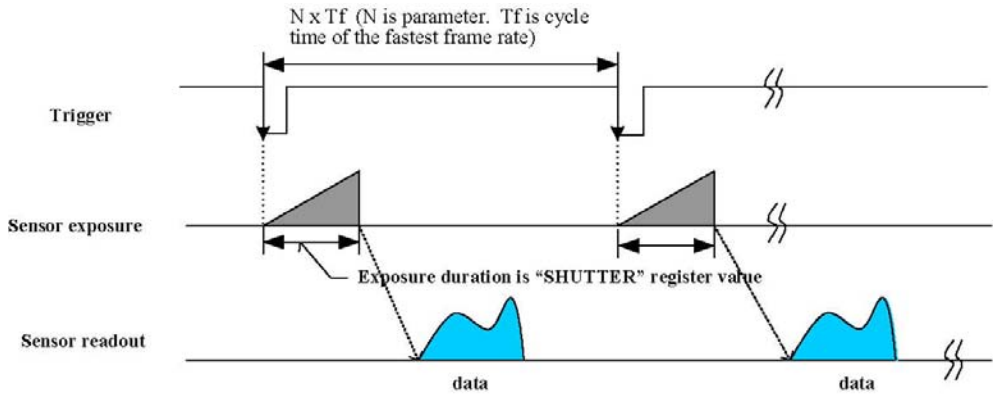
4.9.8. Trigger Mode 3

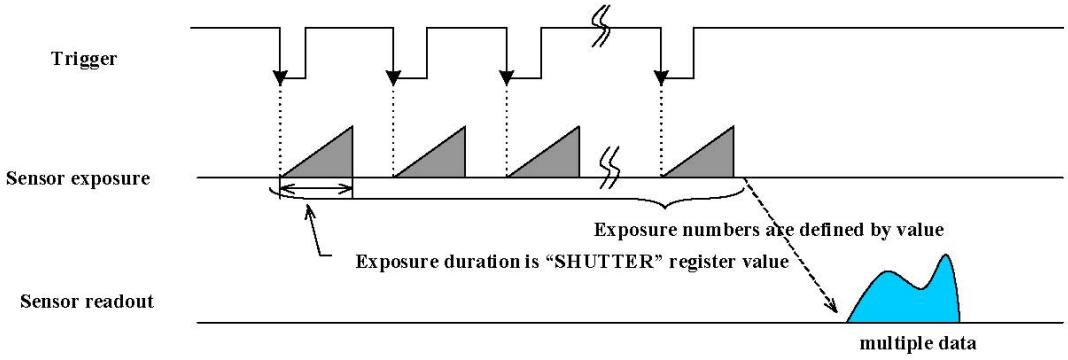
Not supported at Format 7 Mode

This is an internal trigger mode. Camera will issue trigger internally and cycle time is N times (parameter) of the cycle time of fastest frame rate. Integration time of incoming light is described in “Shutter” register. Parameter is required and shall be one or more (N>=1)


N x Tf (N is parameter. Tf is cycle time of the fastest frame rate)
Trigger
Sensor exposure
Exposure duration is “SHUTTER” register value
Sensor readout
data
data

4.9.9. Trigger Mode 4

This mode is “multiple shutter preset mode”. Camera starts integration of incoming light from first external trigger input falling edge and exposes incoming light at shutter time. Repeat this sequence the N-th (parameter) external trigger input falling edge then finish integration. Parameter is required and shall be one or more. (N >= 1)



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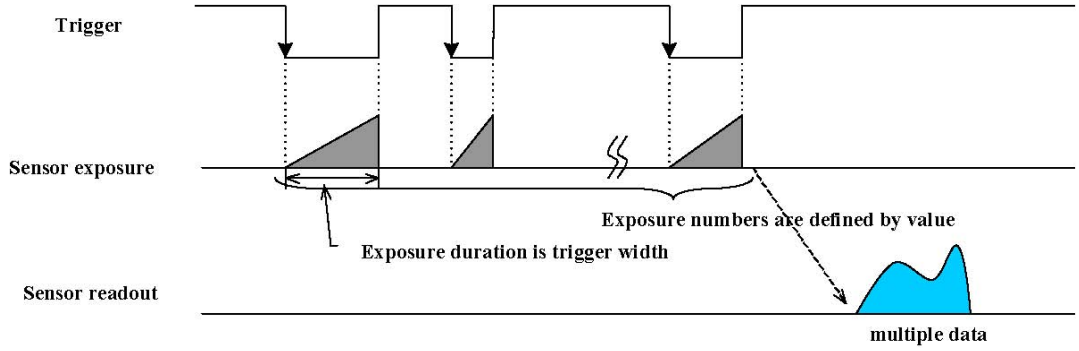
4.9.10. Trigger Mode 5

This mode is “multiple shutter pulse width mode”. Camera starts integration of incoming light from first external trigger input falling edge and exposes incoming light until trigger is inactive. Repeat this sequence the N-th (parameter) external trigger input falling edge then finish integration. Parameter is required and shall be one or more. (N >= 1)

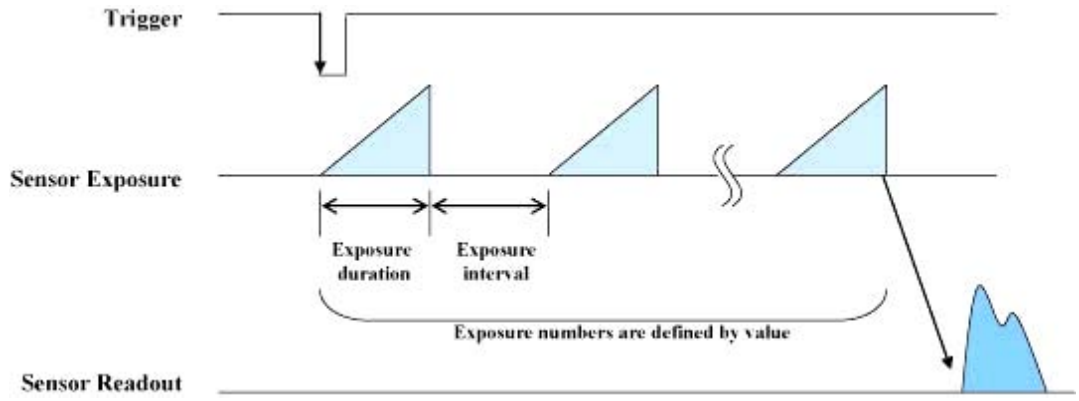


4.9.11. Trigger Mode 14

NET GmbH’s Vender Unique Mode

This mode is “preset multiple shutter mode with a single trigger” . This mode is Similar to “trigger mode 4” but the difference is that all the parameter is preset by the users using only a single trigger. “Exposure Number”, “Exposure Duration”, and “Exposure Interval” are the parameters required for this mode however the exposure duration and interval in each multiple shutter is equal and cannot be different.

Exposure duration & interval is defined by user defined 1394 address(0xF2F10114)



4.9.12. Trigger Mode 15

Tigger mode 15 is the new functions which is upgraded for micom version 3.0. User can capture the images as many as they want with one external trigger signal. That is, so, this mode can be called ‘One-trigger Multi-frames’. For this mode 15, the value of shutter time should be fixed. The mode 15 is supported by both H/W trigger and S/W trigger.

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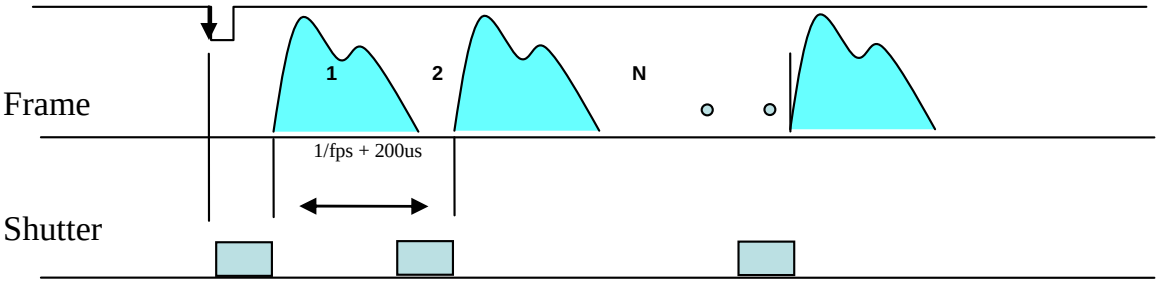
Trigger mode 15 : One-trigger Multi-frames

External



N : 1 ~ 255

Control Address :
0xF0F00830

830h	TRIGGER_MODE	Presence_Inq	[0]	Presence of this feature. 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in the Value field 1: Control with value in the Absolute value CSR If this bit = 1, value in the Value field is ignored.
		-	[2..5]	Reserved.
		ON_OFF	[6]	Write: ON or OFF this feature, Read: read a status 0: OFF, 1: ON If this bit =0, other fields will be read only.
		Trigger_Polarity	[7]	Select trigger polarity (Except for software trigger) If Polarity_Inq is "1", Write to change polarity of the trigger input Read to get polarity of the trigger input. If Polarity_Inq is "0", Read only. (0: Low active input, 1: High active input)
		Trigger_Source	[8..10]	Select trigger source Set trigger source ID from trigger source ID_Inq
		Trigger_Value	[11]	Trigger Input raw signal value Read only 0:Low, 1:High
		Trigger_Mode	[12..15]	Trigger mode. (Trigger_Mode_0..15)
		-	[16..19]	Reserved
		Parameter	[20..31]	Parameter for trigger function, if required. (Optional)

Number of frame

Caution:
At trigger mode 15, Shutter value may be not changed. This operation may loss the frames and the next trigger.
Therefore, the shutter value must be changed before trigger generation or trigger enable command.

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4.10. Strobe Control Register

Base Address : 0xF2F23000h

Address	Name	Field	Bit	Description
000h	Strobe_CTRL_Inq	Strobe_0_Inq	[0]	Presence of strobe 0 signal
		Strobe_1_Inq	[1]	Presence of strobe 1 signal
		Strobe_2_Inq	[2]	Presence of strobe 2 signal
		Strobe_3_Inq	[3]	Presence of strobe 3 signal
		-	[4..31]	Reserved
004h . . 0FCh	Reserved			
100h	Strobe_0_Inq	Presence_Inq	[0]	Presence of this function
		-	[1..3]	Reserved
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/Off_Inq	[5]	Capability of switching this function ON and OFF
		Polarity_Inq	[6]	Capability of changing polarity of the signal
		-	[7]	Reserved
		Min_Value	[8..19]	Minimum value of this function control
		Max_Value	[20..31]	Maximum value of this function control
104h	Strobe_1_Inq	Same definition to Strobe_0_Inq		
	Strobe_2_Inq	Same definition to Strobe_1_Inq		
	Strobe_3_Inq	Same definition to Strobe_2_Inq		
110h . . 1FCh	Reserved			
200h	Strobe_0_Cnt	Presence_Inq	[0]	Presence of this function 0:N/A 1: Available
		-	[1..5]	Reserved
		ON_OFF	[6]	Write : ON or OFF this function Read: read a status 0: OFF, 1: ON if this bit=0, other fields will be read only

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		Signal Polarity	[7]	Select signal polarity If Polarity_Inq is “1” Write to change polarity of the strobe output Read to get polarity of the strobe output If Polarity_Inq is “0” Read only (0: low active output, 1: High active output)
		Delay_Value	[8..19]	Delay after start of exposure until the strobe signal asserts
		Duration_Value	[20..31]	Duration of the strobe signal A value 0 means dessert at the end of exposure function if required.
204h	Strobe_1_Cnt	Same definition to Strobe_0_Inq		
208h	Strobe_2_Cnt	Same definition to Strobe_1_Inq		
20Ch	Strobe_3_Cnt	Same definition to Strobe_2_Inq		
210h . . 2FFh	Reserved			

4.11. Trigger Delay Control

Based on external triggers users can delay image acquisition by the trigger delay control feature. FOculus T Series support the IIDC V1.31 specification for trigger delay control as per the following tables.

Trigger Delay Table

Trigger Delay Index (Y)	Incremental Step	Trigger Delay Time : T	
		Delay Time	Range
1 ~ 500	1 us	T = Y us	1us ~ 500 us
501 ~ 1000	10 us	T = (Y - 500) * 10 + 500	510 us ~ 5500 us
1001 ~ 1445	100 us	T = (Y - 1000) * 100 + 5500 us	5.6 ms ~ 50 ms

Trigger Delay Example Table

Index	1	10	100	500	550	650	950	1045	1145	1445
Time	1 us	10 us	100 us	500 us	1 ms	2 ms	5 ms	10 ms	20 ms	50ms

Inquiry Register

Address	Name	Field	Bit	Description
534h	TRIGGER_DLY_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF

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		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)
		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

Status Control Register

Address	Name	Field	Bit	Description
834h	TRIGGER_DELAY	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..5]	Reserved
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status 0: OFF, 1:ON If this bit=0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

4.11.1. Strobe Delay and Duration Table

4.11.1.1. FOculus T CCD Series

The table shows the strobe index by the increment step through strobe delay time and strobe duration time. Increment Step is different according to strobe index. FO323Tx/FO124Tx and FO531Tx/FO432Tx have the different range for strobe delay and duration in the index table.

Strobe Delay/Duration Table				
Strobe Index(Y)	Increment Step	Strobe Delay Time : T		
		Delay Time	Duration Time	Range
0		0us	N.A	
1		1us	N.A	
2		2us	2us	
3~250	1us	T=Y us	T=Y us	3us~250us
251~489	250us	T=(Y-250)*250us+250us	T=(Y-250)*250us+250us	500us~60ms

Strobe Delay/Duration Index	Strobe Delay Time	Strobe Duration Time
0	0us	N.A
1	1us	N.A
2	2us	2us
10	10us	10us
100	100us	100us
250	250us	250us

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253	1ms	1ms
257	2ms	2ms
269	5ms	5ms
289	10ms	10ms
329	20ms	20ms
449	50ms	50ms
489	60ms	60ms

4.11.1.2. FOculus T CMOS Series

Strobe Index (Y)	Incremental Step	Trigger Delay Time : T		
		Delay Time	Duration Time	Range
0		0 us	1 us	
1		1 us	1us	
2		2 us	2 us	
3 ~ 250	1 us	T = Y us	T = Y us	3 us ~ 250 us
251 ~ 489	250 us	T=(Y-250)*250us+250us	T=(Y-250)*250us+250us	500 us ~ 60ms

Strobe Delay / Duration Index

Index	0	1	10	100	250	253	257	269	289	329	449	489
Delay Time	0us	1us	10us	100us	250us	1ms	2ms	5ms	10ms	20ms	50ms	60ms
Duration Time	2us	1 us	10 us	100 us	250 us	1ms	2ms	5ms	10ms	20ms	50ms	60ms

4.12. Optical Filter Control

Optical Filter control allow user to change the optical filter of the camera lens function. You can change the Bayer patterns by moving the starting position which to output pixel data by one position up, down, right or left. (Only for color models)

Inquiry Register

Address	Name	Field	Bit	Description
58Ch	OPTICAL_FILTER_INQ	Presence_Inq	[0]	Presence of this feature
		Abs_Control_Inq	[1]	Capability of control with absolute value
		-	[2]	Reserved
		One_Push_Inq	[3]	One push auto mode (Controlled automatically by camera only once)
		ReadOut_Inq	[4]	Capability of reading the value of this feature
		On/OFF_Inq	[5]	Capability of switching this feature ON and OFF
		Auto_Inq	[6]	Auto Mode (Controlled automatically by camera)
		Manual_Inq	[7]	Manual Mode (Controlled by user)

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		Min_Value	[8..19]	Minimum value for this feature control
		Max_Value	[20..31]	Maximum value for this feature control

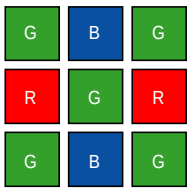
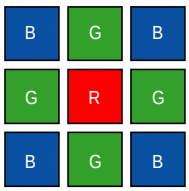
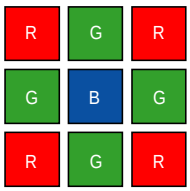
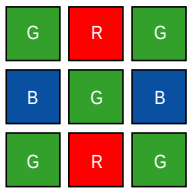
Status Control Register

Address	Name	Field	Bit	Description
88Ch	OPTICAL_FILTER	Presence_Inq	[0]	Presence of this feature 0:N/A 1:Available
		Abs_Control	[1]	Absolute value control 0: Control with value in Value field 1: Control with value in Absolute value CSR if this bit =1, value in Value filed is ignored
		-	[2..5]	Reserved
		On/OFF	[6]	Write : ON or OFF this feature Read : read a status 0: OFF, 1:ON If this bit=0, other fields will be read only.
		-	[7..19]	Reserved
		Value	[20..31]	Minimum value for this feature control

4.13. Color (Bayer) Patterns Conversion

Color sensors capture images through a optical low pass filter placed over the individual pixel in Bayer mosaic layout. Imaged data are transferred by passing color processing which can save bandwidth gaining higher frame rate and flexibility of applying different Bayer Pattern on the PC side.

Obtained Images can be processed in either of the following 4 different conversion algorithm can on the PC side.

Modes	Mode 0 GB/RG	Mode 1 BG/GR	Mode 2 RG/GB	Mode 3 GR/BG
Color(Bayer) Pattern				

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5. Advanced Features

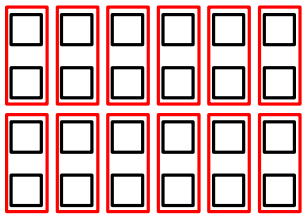
5.1. Binning Mode

Binning is defined as reading neighboring pixel and combining directly from the CCD of the camera. Binning is has an advantage in the following situation and my further be used in various applications. Relative binning mode per camera model is described in each camera specification.

- Low Light Operation : Combining neighboring pixel increases the area of the CCD receiving light thus may obtain brighter picture in low light condition with possible noise reduction.
- High Frame Rate Operation : Vertical Binning accelerates the speed of CCD data transfer rate by combining multiple vertical line per single horizontal line of the CCD resulting a significant gain in frame rate.

5.1.1. Vertical Binning

Vertical binning combines CCD pixels neighboring vertically to a single pixel increasing light sensitivity of the camera. Since CCD acquire data horizontally, multiple lines are acquired in case of vertical binning which results significant speed gain. Thus the vertical resolution is reduced and due to the increased CCD area over exposure may occur which may require adjustment.

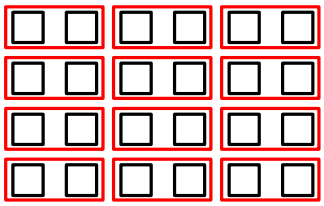


1x2 Vertical Binning

Example

5.1.2. Horizontal Binning

Horizontal binning combines CCD pixel neighboring horizontally to a single pixel increasing light sensitivity of the camera. However due to the nature of CCD transferring each horizontal line at a time there is no speed gain in horizontal binning. However light sensitivity increase may occur, due to the increased CCD area similar to vertical binning and horizontal resolution is reduced.



2x1 Horizontal Binning

Example

5.1.3. Full Binning

Full binning mode can be obtained by combining vertical and horizontal binning. First horizontal pixels are combined followed by a vertical conjunction of these pixels. This would increase light sensitivity by a factor of 4 in case of 2 x

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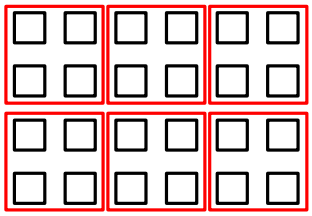
2 (Horizontal x Vertical) binning. However as described above, only vertical binning would result speed gain while horizontal binning gives no speed gain thus speed gain results as similar to vertical binning. Resolution in this mode would be reduced both horizontally and vertically.



2x2 Full Binning

Example

5.2. Partial Scan

Cameras are defined of a certain resolution according to the image sensor while often a certain region maybe of an interest to the user. The partial scan mode provides the function to provide output of a certain region of interest (ROI) which may have advantage in data transfer speed resulting faster operation. As described in binning mode speed gain would occur only in vertical resolution decrease. Partial Scan is supported only in Format 7 by setting the following registers described in the IIDC1.31 specification. Unit size of the partial scan is described in the camera specification which user must consider in increment configuration.

IMAGE_POSITION & IMAGE_SIZE register

Left = Hposunit * n1

Top = Vposunit * m1

Width = Hunit * n2

Height = Vunit * m2

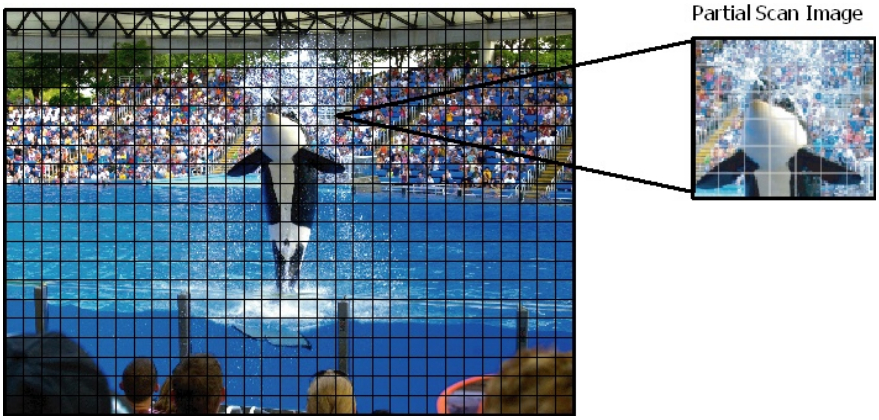
Left + Width < = Hmax

Top + Height < = Vmax

(n1,n2, m1, m2 are integer)

0 - 7	8 – 15	16 – 23	24 - 31
Left		Top	
0 - 7	8 – 15	16 – 23	24 - 31
Width		Height	

Initial Values	System Dependant
Read Values	Last Update Value
Write Effect	Stored



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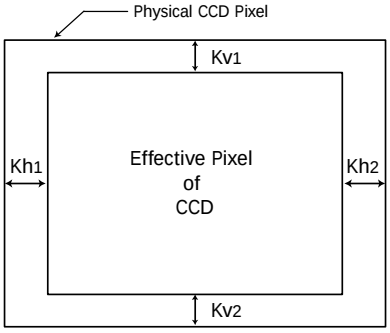
5.2.1. Pan/Tilt

Pan/Tilt is a function used to move a camera up and down or left and right. However unlike the mechanical Pan /Tilt which is carried out by physically moving the camera up and down, this functions by using smaller video mode than the CCD's effective pixel and moving the image up and down. This results of a cut off pixel from the whole image which user can specify by the Pan/Tilt command. Pan/Tilt range and values depend on the characteristic of each CCD used in the camera respectively as per the following tables. Note that at Format 7 mode, the pan/tilt value must be set at non-format 7 mode before operation.



$Kh = Kh_1 + Kh_2$ $Kv = Kv_1 + Kv_2$

5.2.1.1. FOculus T CCD Series

Pan/Tilt Details for FO124TB and FO124TC

Image Size	Movement	FO124TB Kh =12, Kv=12		FO124TC Kh=8, Kv=10	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 492	326	160 ~ 488	324
	Tilt	120 ~ 372	246	120 ~ 370	242
640 x 480	Pan	320 ~ 332	326	320 ~ 328	324
	Tilt	240 ~ 252	246	240 ~ 250	242

*At format7 mode, PAN/TITL value must be set at non-format7 mode.

Pan/Tilt Details for FO323TB and FO323TC

Image Size	Movement	FO323TB Kh=8, Kv=8		FO323TC Kh=8, Kv=8	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
320 x 240	Pan	160 ~ 872	516	160 ~ 872	516
	Tilt	120 ~ 656	388	120 ~ 656	388
640 x 480	Pan	320 ~ 712	516	320 ~ 712	516
	Tilt	240 ~ 536	388	240 ~ 536	388
800 x 600	Pan	400~632	516	400~632	516
	Tilt	300~476	388	300~476	388
1024 x 768	Pan	400 ~ 632	516	400 ~ 632	516
	Tilt	300 ~ 476	388	300 ~ 476	388

*At format7 mode, PAN/TITL value must be set at non-format7 mode

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5.2.1.2. FOculus T CMOS Series

Pan/Tilt Details for FO1224TB and FO1224TC

Image Size	Movement	FO1224TB		FO1224TC	
		Range(Incr.=1)	Default	Range(Incr.=2)	Default
640 x 480	Pan	320 ~ 430	376	320 ~ 430	376
	Tilt	220	220	220	220
752 x 480, 752 x 476 Format 7 Mode 0	Pan	376	376	376	376
	Tilt	220	220	220	220
376 x 240 (2x2bin.) Format 7 Mode 1	Pan	376	376		
	Tilt	220	220		

Pan/Tilt Details for FO1433TB

Image Size	Movement	FO1433TB	
		Range (H_Incr.=2, V_Incr.=1)	Default
640 x 480	Pan	320 ~ 960	640
	Tilt	240 ~ 784	512
800 x 600	Pan	400 ~ 880	640
	Tilt	300 ~ 724	512
1024 x 768	Pan	512 ~ 768	640
	Tilt	384 ~ 640	512
1280 x 960	Pan	640	640
	Tilt	496 ~ 528	512
1280 x 1024 Format 7 Mode 0	Pan	640	640
	Tilt	512	512

Pan/Tilt Details for FO1631TC

Image Size	Movement	FO1631TC	
		Range (Incr.=2)	Default
640 x 480	Pan	320 ~ 1728	1024
	Tilt	240 ~ 1296	768
800 x 600	Pan	400 ~ 1648	1024
	Tilt	300 ~ 1236	768
1024 x 768	Pan	512 ~ 1536	1024
	Tilt	384 ~ 1152	768
1280 x 960	Pan	640 ~ 1408	1024
	Tilt	480 ~ 1056	768
1600 x 1200	Pan	800 ~ 1248	1024
	Tilt	600 ~936	768
2048 x 1536 Format 7 Mode 0	Pan	1024	1024
	Tilt	768	768
1024 x 768 (2x2 bin.) Format 7 Mode 1	Pan	1024	1024
	Tilt	768	768

*At format7 mode, PAN/TITL value must be set at non-format7 mode

5.3. One-Shot and Multi-Shot

This camera supports One-Shot and Multi-Shot features. The camera should be in a Iso_disabled mode before the execution of these command and if the camera is Iso_enabled mode these commands are ignored. One-Shot and Multi-Shot can be used combined with a hardware trigger which grabs either one frame or multi frame according to

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the command respectively. The command can be executed configuring the following registers.

One-Shot		Multi-Shot	
Address	F0F0061CH	Address	F0F0061CH
Data	80000000h	Data	4000nnnh

nnnn is the number of frames output which can be from any number between 0001h ~ FFFFh.(1~ 65,535)

Priority of the command execution is as follows. Continuous > One-shot > Multi-shot.

When a command with higher priority is being executed the command with lower priority shall be ignored.

5.4. Multi-Camera Auto-sync.

Not supported in 3.75 fps In application incorporating multi camera, there is often a need to synchronize the cameras. Multi-Camera Auto Synchronization is supported utilizing the FireWire bus time cycle register which are connected on the same FireWire bus without external signal. Max 3 cameras can be supported for auto-sync on one Ohci card. So, the video mode of the camera must be set within the limit a single FireWire bus bandwidth of 400Mbps. Also maximum shutter value be set as per the table below not exceeding the FireWire bus cycle time. Jitter may occur due to CPU operation timing. In the auto-sync, the shutter time and the fps should be set maintained.

FPS	FO124Tx		FO323Tx		FO432Tx		FO531Tx	
	Max Shutter		Max Shutter		Max Shutter		Max Shutter	
	Value	Time	Value	Time	Value	Time	Value	Time
60	1110	16.5ms	-	-	-	-	-	
30	1276	33.1ms	1270	32.5ms	-	-	-	-
15	1608	66.3ms	1598	65.3ms	1612	66.7ms	1606	66.1ms
7.5	1760	131ms	1758	129ms	1761	132ms	1760	131ms
3.75	1893	264ms	1889	260ms	1895	266ms	1893	264ms

To utilize Auto-sync, please set Bit 31 to Auto-sync Enable, then check the Bit 27 to verify whether it is ready. Please refer the details as the following table.

0xF2F10018	**Auto-Sync Mode control register** Bit 31 : auto sync enable Bit 30 : SIO enable mode (0 : NET GMBH mode, 1 : IIDC v1.31) Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)	Read/Write

5.5. Asynchronous Broadcasting.

Asynchronous broadcasting is supported where using node 63 of the FIREWIRE bus is used as a target node for asynchronous write request. This enables all the camera to be triggered by software simultaneously. By utilizing Asynchronous Broadcasting user can execute and control all the camera on the same FIREWIRE bus at the same time with a single command.

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5.6. Memory Channel Save / Load

The setting of the camera features (Shutter, Gain...) and video mode can be stored in a non-volatile memory. Our camera supports 16 memory channels as per the table below for user to conveniently save and load different features as well as video modes. Channel 0 is for factory default and Channel 1~4 are for features saving and Channel 5~15 are for resolution and mode and frame rate plus feature saving.

Address	Name	Bit	Description
618h	Memory_Save	[0]	Saves the current setting
		[1..31]	Reserved
Address	Name	Bit	Description
620h	Mem_Save_Ch	[0]	Factory Default Setting Cannot overwrite
		[1..4]	Write Channel for Memory Save for Channel 1 ~ 4 (Only for Features)
		[5..15]	Write Channel for Memory Save for Channel 5 ~ 15 (For Features, Format and Mode Save)
Address	Name	Bit	Description
624h	Cur_Save_Ch	[0]	Read and Load Factory Default Setting
		[1..4]	Read and Load Memory Channel 1 ~ 4
		[5..15]	Read and Load Load Memory Channel 5 ~ 15

User Defined FireWire Register Control

Address	Description(bit : msb*)	Read/Write
0xF2F1011C	**Power on default memory channel** Bit 0 ~ Bit 3 : power on initial memory channel	Read/Write

5.7. Time Stamp Register.

Time stamp register may be inquired from the Native FireWire Bus (IEEE-1394.a) CYCLE_TIME registers as follows. You may also get the same value from user defined registers (See Chap. 6.1) but we recommend using this.

Address	Description(bit : msb*)	Read/Write
0xF0000200	**CYCLE_TIME** 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 SECONDS COUNT | CYCLE COUNT | CYCLE OFFSET	Read

Bit Number	Bit Name	Function	DIR	Description
0 - 6	SECONDS COUNT	Seconds Count	R/W	1 Hz cycle timer counter
7 - 19	CYCLE COUNT	Cycle Count	R/W	8,000 Hz cycle timer counter
20 - 31	CYCLE OFFSET	Cycle Offset	R/W	24.576 MHz cycle timer counter

5.8. Serial Interface

FOculus T Series are equipped with SIO(Serial input/output) feature described in the IIDC 1.31 specification. By using the serial interface, users can execute commands by writing data in a specific address in the FIREWIRE address range. SIO can be further used as a RS232 interface which supports pass through and NET GmbH command..

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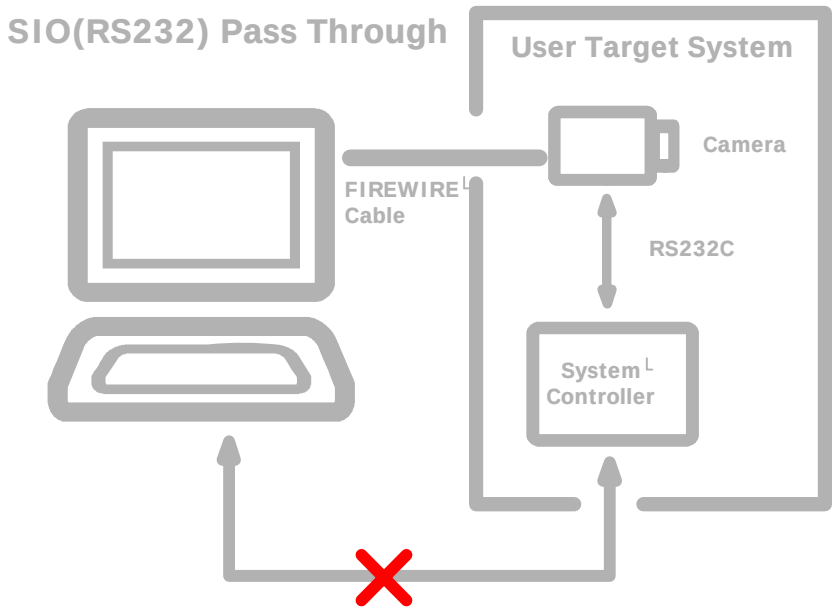
5.8.1. SIO Pass Through Scheme



5.8.2. SIO (RS232) Control Setting Procedure

STEP 1. Configuration of Registers Address : F2F22000h

Baud Rate : 9600, No Parity, 1 bit Stop, 8 bit data length

Write : F2F22000h, Data = 050800000h

Value read after write = 050800020h 20 is the buffer of TX and RX

STEP 2. Enable RS232 TX / RX Address : F2F22004h

Write Data : C00000000 : Now RS232 TX / RX port is enabled

5.8.3. SIO (RS232) RX Control Procedure

STEP 1 Read RBUF_ST of the Receive Buffer Status Control Register (address : F2F22008h) and check number of RX data buffered in the camera.

If (RBUF_ST !=0) the RX is Ready else RX is NOT Ready

RBUF_ST : The number of current data buffered in the camera (Unit : byte)

RBUF_CNT : READ : Remaining RX buffer size

STEP 2 Write number of RX data intended to read from RBUF_CNT of the Receive Buffer Status Control Register (address : F2F22008h)

RBUF_CNT can be configured by unit of byte.

The value of RBUF_CNT must be smaller than RBUF_ST.

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STEP 3 Read RS232 RX data from SIO_Data_Register (addr. : F2F22100)

STEP 4 If data is further required repeat from STEP1

Note that 1394 data consist of 32 bit data the data read should

Bit 0 ~ Bit 7 : 1st Data Bit 8 ~ Bit 15 : 2nd Data

Bit 16 ~ Bit 23 : 3rd Data Bit 24 ~ Bit 31 : 4th Data

Bit 0 : Msb Bit 31 : Lsb

5.8.4. SIO (RS232) TX Control Procedure Method I

STEP 1 Check TX buffer size by reading TBUF_ST of the Transmit_Buffer_Status_Control register(Addr. : F2F220Ch)

If ((TBUF_ST == Buffer_Size_Inq) or (TBUF_TDRD ==1)) then TX is COMPLETE else TX is INCOMPLETE

TBUF_ST : Current TX Data buffer(Unit:byte) of the camera

TBUF_CNT : Read : Number of data transmitted by RS232 TX

Buffer_Size_Inq : Defined in Serial_Mode_Reg(Addr. : F2F22000h)

Ex) 20050000h : valid data buffer size = 20 number of data sent : 05

STEP 2 Write number of RS232 TX data to be set for TBUF_CNT at SIO_Data_Register(Addr: F2F22100h)

STEP 3 Write number of TX data to be transferred to TBUF_CNT of Transmit_Buffer_Status_Control Register(Addr:F2F2200Ch)

TBUF_CNT can be configured by unit of byte.

The value of TBUF_CNT must be smaller than data written at SIO_Data_Register.

If (write data number > = TBUF_CNT)

{

RS232TX Start

Write Data number larger that TBUF_CNT is discarded.

For example if TBUF_CNT = 5 , in IEEE-1394 write is done by a unit of 4 bytes where 8 bytes shall be written at SIO_Data_Register but only 5 bytes are transmitted and the 3 bytes remaining shall be discarded.

}

STEP4 If there is data to be transmitted repeat from Step 1 .

Bit 0 ~ Bit 7 : 1st Data Bit 8 ~ Bit 15 : 2nd Data

Bit 16 ~ Bit 23 : 3rd Data Bit 24 ~ Bit 31 : 4th Data

Bit 0 : Msb Bit 31 : Lsb

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5.8.5. SIO (RS232) TX Control Procedure Method II

STEP 1 Check TX buffer size by reading TBUF_ST of the Transmit_Buffer_Status_Control register(Addr. : F2F220Ch)

If ((TBUF_ST == Buffer_Size_Inq) or (TBUF_TDRD ==1)) then TX is COMPLETE else TX is INCOMPLETE

TBUF_ST : Current TX Data buffer(Unit:byte) of the camera

TBUF_CNT : Read : Number of data transmitted by RS232 TX

Buffer_Size_Inq : Defined in Serial_Mode_Reg(Addr. : F2F22000h)

Ex) 20050000h : valid data buffer size = 20 number of data sent : 05

STEP 2 Write number of RS232 TX data to be set for TBUF_CNT at Transmit_Buffer_Status_Control Register(Addr:F2F2200Ch)

TBUF_CNT can be configured by unit of byte.

The value of TBUF_CNT must be smaller than data written at SIO_Data_Register.

STEP 3 Write RS232 TX data set at TBUF_CNT to SIO_Data Register(Addr. : F2F22100h)

If (write data number > = TBUF_CNT)

{

RS232TX Start

Write Data number larger that TBUF_CNT is discarded.

For example if TBUF_CNT = 5 , in IEEE-1394 write is done by a unit of 4 bytes where 8 bytes shall be written at SIO_Data_Register but only 5 bytes are transmitted and the 3 bytes remaining shall be discarded.

}

STEP4 If there is data to be transmitted repeat from Step 1 .

Bit 0 ~ Bit 7 : 1st Data Bit 8 ~ Bit 15 : 2nd Data

Bit 16 ~ Bit 23 : 3rd Data Bit 24 ~ Bit 31 : 4th Data

Bit 0 : Msb Bit 31 : Lsb

5.8.6. SIO(RS232) Registers

Base address: F2F22000h, default baud rate is 57600

Address	Name	Field	Bit	Description
000h	Serial_Mode_Reg	Baud Rate	[0..7]	Baud Rate Setting Write : Set baud rate Read : Get current baud rate 0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200bps 10: 230400bps Other value reserved.

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		Char_Length	[8..15]	Character length setting Write: Set data length(must not be 0) Read : Get data length 7: 7 bits 8: 8 bits Other values reserved.
		Parity-	[16..17]	Parity setting Write : Set Parity Read : Get current parity 0: None 1 : Odd 2 : Even
		Stop_bit	[18..19]	Stop bits Write : Set stop bit Read : Get current stop bit 0: 1 1: 1.5 2: 2.
		-	[20..23]	Reserved
		Buffer_Size_Inq	[24..31]	Buffer Size (Read Only) This field indicates the maximum size of receive/transmit data buffer. If this value=1, Buffer_Status_Control, SIO_Data_Register Char1-3 should be ignored
004h	Serial_Control_Reg	RE	[0]	Receive enable Read : Current status Write : 0 : Disable 1: Enable
		TE	[1]	Transmit enable Read : Current status Write : 0 : Disable 1: Enable
		-	[2..7]	Reserved
	Serial_Status_Reg	TDRD	[8]	Transmit data buffer ready Read only 0 : Not ready 1: Ready
		-	[9]	Reserved
		RDRD	[10]	Receive data buffer ready Read only 0 : Not ready 1: Ready
		-	[11]	Reserved
		ORER	[12]	Receive buffer over run error Read : Current status Write : 0: Clear flag 1: Ignored
		FER	[13]	Receive data framing error Read : Current status Write : 0: Clear flag 1: Ignored
		PER	[14]	Receive data parity error Read : Current status Write : 0: Clear flag 1: Ignored
		-	[15]	Reserved
008h	Receive_Buffer_Status_Control	RBUF_ST	[0..8]	SIO receive buffer status Read : Valid data size of current receive buffer Write : Ignored
		RBUF_CNT	[8..15]	SIO receive buffer control Read : Remain data size for read Write : Set input data size

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		-	[16..31]	Reserved
00Ch	Transmit_Buffer_Status_Control	TBUF_ST	[0..7]	SIO ouput buffer status Read : Available data space of transmit buffer Write : Ignored
		TBUF_CNT	[8..15]	SIO output buffer control Read : Written data size to buffer Write : Set output data size for transmit
		-	[16..31]	Reserved
010h .. 0FFh				Reserved
100h	SIO_Data_Register	Char_0	[0..7]	Chracter_0 Read : Read character from receive buffer Padding data, if data is not available Write : Character to transmit buffer padding data if data is invalid
		Char_1	[8..15]	Chracter_1 Read : Read character from receive buffer +1 Padding data, if data is not available Write : Character to transmit buffer +1 padding data if data is invalid
		Char_2	[8..15]	Chracter_2 Read : Read character from receive buffer +2 Padding data, if data is not available Write : Character to transmit buffer +2 padding data if data is invalid
		Char_3	[16..31]	Chracter_3 Read : Read character from receive buffer +3 Padding data, if data is not available Write : Character to transmit buffer +3 padding data if data is invalid
104h .. 1FFh	SIO_Data_Register_Alias		[0..31]	Alias SIO_Data_Register area for block transfer

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5.8.7. SIO(RS232) NET GmbH Commands

0xF2F10018	**Auto-Sync Mode control register** Bit 31 : auto sync enable Bit 30 : SIO enable mode (**0 : NET GmbH mode**, 1 : IIDC v1.31) Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)	Read/Write

NET GmbH Commands are valid when the Bit30 is to be set “0”(zero).

SIO(RS232) NET GmbH commands are non IIDC compliant which is a specific mode for NET cameras.

Before using these commands serial communication parameters must be set at **Serial_Mode_Reg(F2F22000h)**

F2F10018 means that the RS232 command is valid.

Baud Rate	Stop Bit	Parity	Flow Control
57600 bps(default)	1 bit	None	Non

- **Command format : [STX] [Command] [Data] [ETX]**

  [STX] : Command start character : ‘S’

  Command] : Command length is 2byte. See next page command table.

  [Data] : Data length is varied with each command. Data format is hexadecimal: ‘0’~’9’, ‘A’~’F’.

  [ETX] : Command end character : ‘Z’

- **Return value**

  ‘G’ : Command complete acknowledge.

  “Gdd..d” : “dd..d” is return data and hexadecimal character.

  ‘U’ : Undefined command.

- Valid Character : ‘0’~’9’, ‘A’~’F’, ‘S’,’Z’ Invalid character is received is discarded.

- **example) Gain setting command with 0x200 value.**

  All of “SA0200Z”, “S A0 200 Z”, “SA0 200Z”, “S A0200 Z”, and “SKA0V200Z” are parsed to “SA0200Z Z”, and “SKA0V200Z” are parsed to “SA0200Z”.

- **SIO(RS232) Commands**

STX	Command	Data Length	ETX	Return Value	Function
S	A0	3Bytes	Z	G	**Gain control** (0x000 ~ 0x30F(BW Model) or 2D3(Color Model)) (see gain mapping graph) Ex) SA0200Z : Gain index value 512 (18dB)
S	A1	3Bytes	Z	G	**Shutter speed control** (0x001 ~ 0xCFB) (see shutter speed table)
S	A2	1Bytes	Z	G	**Set/Clear auto shutter speed and auto gain** Bit 0 : Auto gain Bit 1 : Auto shutter speed Ex) SA21Z : set auto gain and clear auto shutter speed SA23Z : set auto gain and auto shutter speed SA20Z : clear auto gain and auto shutter speed
S	A3	2Bytes	Z	G	**Auto exposure control** (0x00~0x64)
S	A4	1Bytes	Z	G	**Gamma control** (0x0~0x19) (see gamma table)
S	A5	3Bytes	Z	G	**Brightness control** (0x000~0x800)

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S	A6	3Bytes	Z	G	**Sharpness control** (0x000~0x3F8)
S	A7	1Bytes	Z	G	**ISO control** 1: ISO enable, 0 : disable
S	A8	1Bytes	Z	G	**Trigger control** 1: trigger enable, 0 : trigger disable
S	AF	0Bytes	Z	'G'+18 Byte	**Read feature control value** Return value order 'G'[Gain] [Shutter] [Set/Clear auto gain and shutter] [Auto Exposure] [Gamma] [Brightness] [Sharpness] [ISO] [Trigger] Ex) At Command SAFZ, if return value is G001200132F20020101, Gain : 0x001 Shutter speed : 0x200 Set auto gain/Clear auto shutter speed : 0x1 Auto exposure : 0x32 Gamma : 0xF Brightness : 0x200 Sharpness : 0x201 ISO : 0x0 Trigger : 0x1
S	B0	16Bytes	Z	G	**RS232 synchronization** : RS232 buffer cleared in camera.
S	B1	8Bytes	Z	G	**Write access of 1394 address** Format : SB1 [address(8 byte)] [data(8byte)] Z Ex) SB1F2F1010012345678Z : write 0x12345678 data at 0xF2F10100 address
S	B2	0Bytes	Z	'G'+8 Byte	**Read access of 1394 address** Format : SB2 [address(8byte)] Z Ex) If command is SB2F2F10100Z and return value is G12345678, Read value of address 0xF2F10100 is 0x12345678.
S	B3	3Bytes	Z	G	**Return to default feature value** Return control feature : gain, shutter speed, auto exposure, brightness, sharpness, gamma, auto shutter speed, auto gain
S	Undefined Command	Any Byte	Z	U	**Undefined command** Return Value is 'U' character.

5.9. Frame Save Function

FOculus T series cameras can save their frames in the memory and the camera stop running in saving the max frame rates in the memory. Max savable frame numbers are different according to FOculus T CCD series. The saved images are useful for multi cameras applications and IEEE1394 images are transferred by ISO channel and 400Mbps is max bandwidth.

of maximum save frames : address 0xF2F10128, bit 16 ~ bit 23 read value		
Resolution	Mode 800	Mode 1600/Y422
640 x 480	63 frames	31 frames
800 x 600	63 frames	31 frames
1024 x 768	31 frames	15 frames
1280 x 960	15 frames	7 frames
1280 x 1024	15 frames	7 frames
1600 x 1200	15 frames	7 frames
2048 x 1536	7 frames	3 frames

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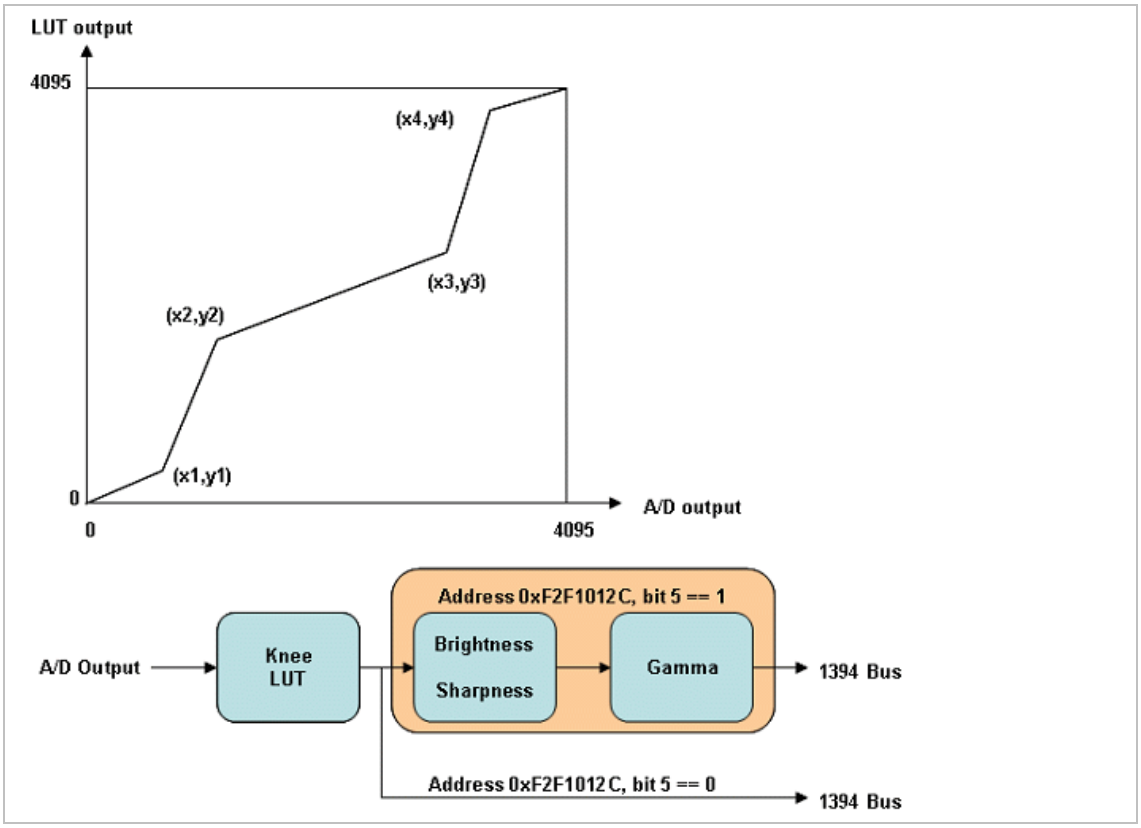
5.10. LUT(Lookup table)

FOculus T series cameras support the LUT, which is providing users with the image with the user's defined dynamic range. Through LUT, users can process the images for the saturation or the dark. The LUT can be used optionally with Brightness and Sharpness and Gamma. However, the applied sequence is that the LUT is applied prior to the features like Brightness and Sharpness and Gamma.

(Priority : LUT > Brightness and Sharpness and Gamma)

5.10.1. 4step knee lookup table

Users can set the 4 points for the images called knee and apply them to LUT.



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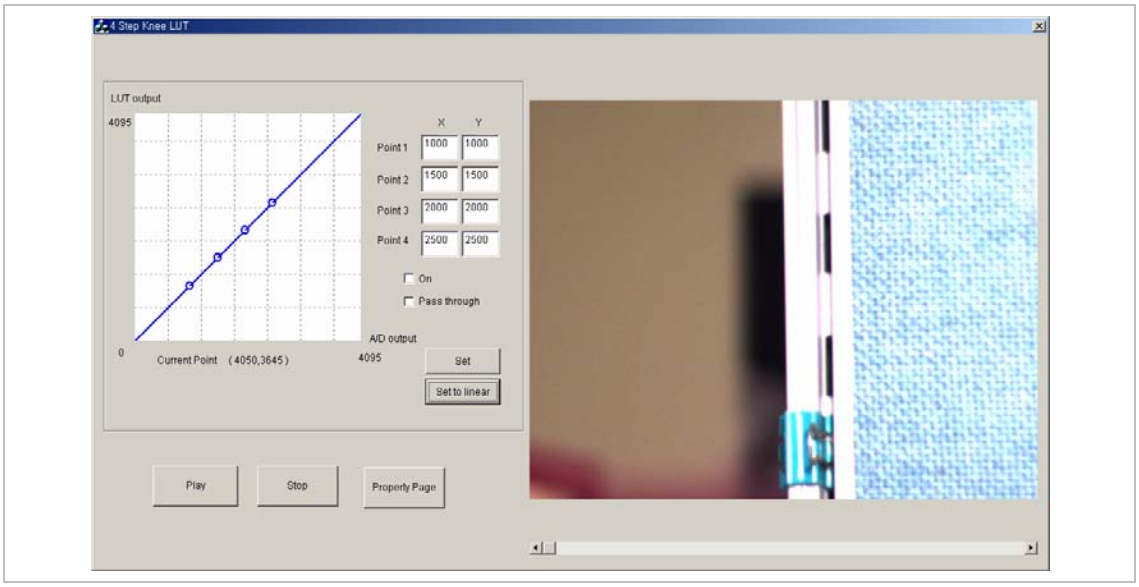
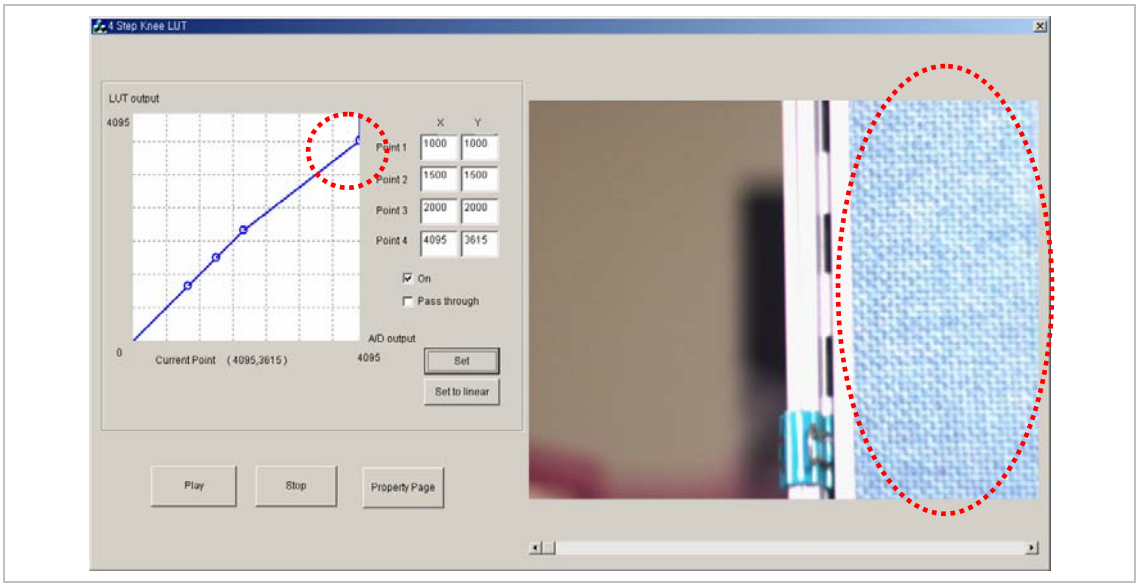


Before Image (before 4 points LUT)



After Image (after 4 points LUT)

5.10.2. User defined lookup table

Users can set their defined points (data file) to the images and so they have to make the data files applied to LUT. And then, User's defined LUT running procedure is as follows. LUT index is N (o~15). The total index numbers of user's defined LUT are 16, but only one user defined LUT is used.

Priority : User's defined LUT > 4 point LUT > Features (Brightness, Sharpness, Gamma)

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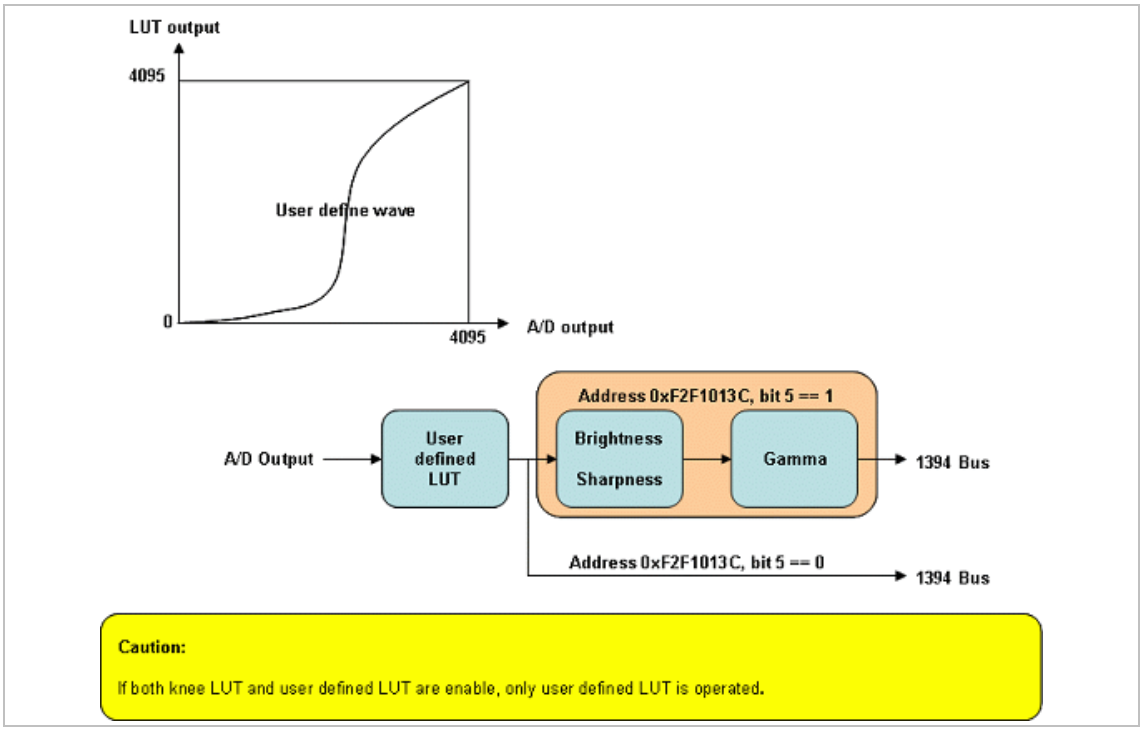

Users should know the user defined LUT save procedure is as follows. Please check save ready bit (bit1) status of LUT save control register (0xF2F10140). If bit 1 is 0, wait. And please write 1 at LUT buffer address init bit(bit7) of LUT save control register(0xF2F10140) : 0xF2F10140 (<= 0x01000000). And then please write 4096 LUT data at LUT data register (0xF2F10144). Finally, please write save command (bit0), LUT index (N : bit8~bit11) at LUT save control register(0xF2F10140) : 0xF2F10140 (<= 0x80N00000).

5.11. One Pixel Snow Noise Remove

This is to average the value of snow noise pixel by using the neighboring pixels values and Operation scheme is as follows. If ((Pi-Pi-1) > Threshold*16) and ((Pi-Pi+1) > (Threshold*16)), Pi is bad pixel. Color camera has no bad pixel remove function. This function is to increase the average pixels values for the whole image and be automatically be displayed and the images can be compensated by over up to 50%. The address for this function is as below.

Address	Description (bit 0: msb)	Read/Write
0xF2F20150	**One Pixel Snow Noise Remove** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 5 : reserved Bit 6 : on/off Bit 7~Bit23 : reserved Bit 24~Bit31 : Threshold Value (T) : If Pixel difference value > Threshold Value, then replace near pixel average Value	Write only

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	One Pixel Snow Noise Remove Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 5 : reserved Bit 6 : on/off Bit 7~Bit23 : reserved Bit 24~Bit31 : Threshold Value (T) : If Pixel difference value > Threshold Value, then replace near pixel average Value	

Before Snow noise image

After Snow noise removal

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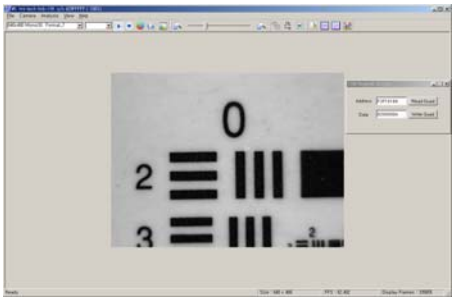
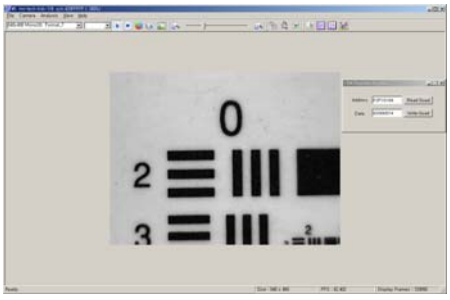
5.11.1. PIO Control Register

Short for Programmable Input/Output, PIO provides a set of IO ports which can be configured by the defined address. It is as follows for PIO control register by IEEE 1394a spec.

Address	Description (bit 0: msb)	Read/Write
0xF2F21000	PIO output register Bit 30 : Strobe GPIO output	Write only
0xF2F21004	PIO input register Bit 31 : trigger GPIO input	Read only
0xF2F21008	PIO GPIO enable register. Bit 30 : Strobe pin GPIO selector (1: GPIO, 0: strobe)	Read/Write

5.12. Edge Enhancement

This feature controls sharpness by enhancing the edges of the image. By applying this feature, the edge of images is sharpened against the ambient noise, which makes it more visible. For address, please refer to the user defined. and control to the desirable level to obtain the best result. This is currently applied only to FOculus T CCD Series.

Before	after
	

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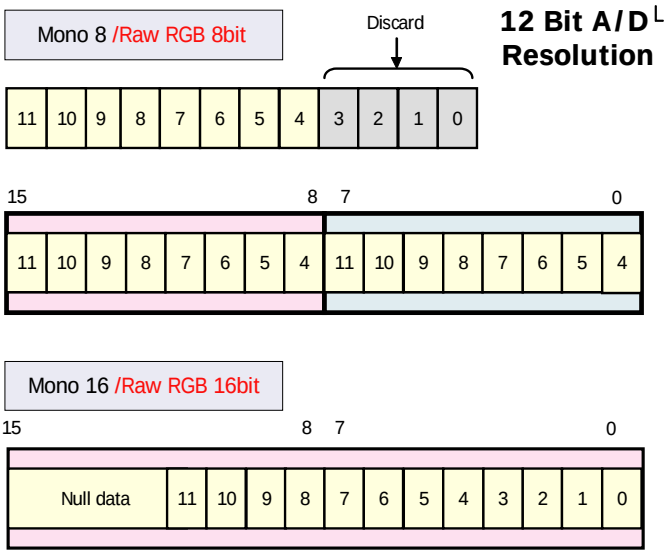
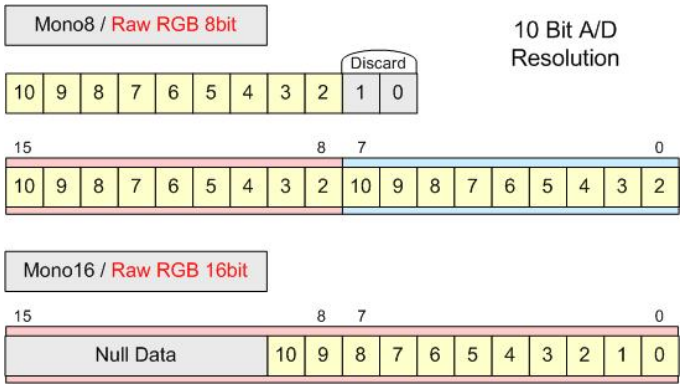
6. User Defined FIREWIRE Registers

User defined registers are features undefined in the IIDC specification which NET cameras are capable of. User can utilize extended features of these NET specific FIREWIRE register for application.

Note that for users who had previous versions of NET Camera, several User Defined Registers have been incorporated in the IIDC V1.31 specification.

6.1. User Defined FIREWIRE Address

FOculus T CCD series

Address	Description(bit : msb*)	Read/Write
0xF2F10000	**A/D bit resolution (FOculus T CCD series)** Bit 28~Bit31 : A/D bit resolution Please refer to IIDC v1.31 data depth register (address: 0xF0F00630) 	Read only
0xF2F10000	**A/D bit resolution** Bit 28~Bit31 : A/D bit resolution Please refer to IIDC v1.31 data depth register (address: 0xF0F00630) 	Read only

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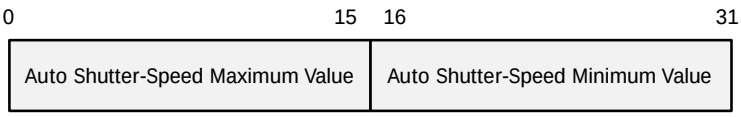
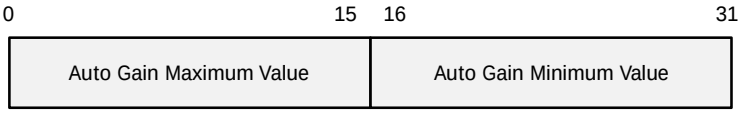
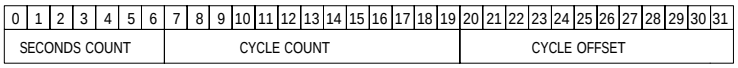
<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>0xF2F10004</td><td>Auto shutter-speed maximum/minimum value register.(32bit)
At auto shutter mode, shutter speed value is checked between auto shutter-speed maximum value and minimum value
 
</td><td>Read/Write</td></tr>
<tr><td>0xF2F10008</td><td>Auto gain maximum/minimum value register.*(32bit)
At auto gain mode, gain value is checked between auto gain maximum value and minimum value.
 
</td><td>Read/Write</td></tr>
</table>

<table>
<tr><td>0xF2F10018</td><td>Mode control register
Bit 31 : auto sync enable
Bit 30 : SIO enable mode (0 : NET GmbH mode, 1 : IIDC v1.31)
Bit 27 : auto sync complete (read only. 1: ready, 0: not yet auto-sync)</td><td>Read/Write</td></tr>
<tr><td>0xF2F1001C</td><td>1394 time stamp register(msb:bit0)
 

<table>
<tr><th>Bit Number</th><th>Bit Name</th><th>Function</th><th>DIR</th><th>Description</th></tr>
<tr><td>0 - 6</td><td>SECONDS COUNT</td><td>Seconds Count</td><td>R/W</td><td>1 Hz cycle timer counter</td></tr>
<tr><td>7 - 19</td><td>CYCLE COUNT</td><td>Cycle Count</td><td>R/W</td><td>8,000 Hz cycle timer counter</td></tr>
<tr><td>20 - 31</td><td>CYCLE OFFSET</td><td>Cycle Offset</td><td>R/W</td><td>24.576 MHz cycle timer counter</td></tr>
</table>
We recommend using native CYCLE_TIME register in Chap. 5.7.</td><td>Read only</td></tr>
<tr><td>0xF2F10100</td><td>Power on reset condition control register
Not Recommended
Please refer to IIDC v1.31 memory save/load channel.</td><td>Read/Write
(Self Cleared)</td></tr>
<tr><td>0xF2F10104</td><td>Trigger control register
Not Recommended
Please refer to IIDC v1.31 trigger control register (address: 0xF0F00830)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10108</td><td>Software trigger
Not Recommended
Please refer to IIDC v1.31 software trigger register (address: 0xF0F0062C)</td><td>Read only</td></tr>
<tr><td>0xF2F1010C</td><td>Strobe control register. Only supports active high polarity.
Not Recommended Please refer to IIDC v1.31strobe control register (address: 0xF0F0048C -> 0xF2F23200)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10110</td><td>Trigger noise filter register (External trigger only)
Bit 22~Bit 31 : trigger masking range (M, unit : usec, range:0~1023)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10114</td><td>Multi-cut exposure & interval time control (for Mode 14)
Bit 16 ~ 31 : exposure time (E)
Bit 0 ~ 15 : exposure time interval (P)</td><td>Read/Write</td></tr>
<tr><td>0xF2F10184</td><td>Local ISO_EN control register for one-shot/multi-shot
Bit 31 : iso_enable (1: enable. 0: disable)</td><td></td></tr>
</table>

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0xF2F1011C	**Power on default memory channel** Bit 0 ~ Bit 3 : power on initial memory channel	Read/Write
0xF2F10200	**Camera version register** Bit 16~Bit 31 : camera version (ex: If reading value: 0x00003000, camera version is 3.000)	Read only
0xF2F10120	**Bright Level for Iris Control Application** Bit 24 ~ Bit 31 : Bright Level for Image Capture	Read only
0xF2F10124	**Test Pattern** Bit 0 : Vertical Grey Bar Bit 1: Bias Grey Bar	Read/Write
0xF2F10128	**Defer Image control (Frame save)** Bit 0 : presence inquiry (read only) Bit 6 : defer image On/Off control (1: image hold mode, 0 : normal real time mode) Bit 7 : send image command : If bit 6 is on status, this bit is send image command from camera to PC. Bit 16 ~ Bit 23 : Queue size inquiry : Must check whenever format or mode is changed (read only) Bit 24 ~ Bit 31 : At read operation, this value is the number of remained image at queue. At write operation, this value is the number of sending images by bit 7 send image command	Read/Write
0xF2F1012C	**4 step knee LUT run control register** LUT knee 1st point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit4 : reserved Bit 5 : enable brightness, sharpness, gamma feature with knee function Bit 6 : On/Off Bit 7 : reserved Bit 8~Bit 19 : X coordination of 1st knee point Bit 20~Bit31 : Y coordination of 1st knee point	Read only
0xF2F10130	LUT knee 2nd point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 2nd knee point Bit 20~Bit31 : Y coordination of 2nd knee point	Read/Write
0xF2F10134	LUT knee 3rd point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 3rd knee point Bit 20~Bit31 : Y coordination of 3rd knee point	Read/Write
0xF2F10138	LUT knee 4th point register Bit 0 : presence inquiry (read only) Bit 1 : LUT regeneration command (self cleared) Bit 2~Bit5 : reserved Bit 6 : reserved Bit 7 : reserved Bit 8~Bit 19 : X coordination of 4th knee point	Read/Write

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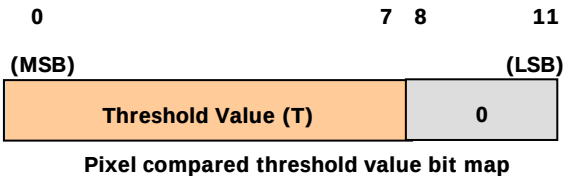
	Bit 20~Bit31 : Y coordination of 4th knee point	
0xF2F1013C	**User defined LUT run control register** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 4 : reserved Bit 5 : enable brightness, sharpness, gamma feature with user defined LUT function Bit 6 : On/Off Bit 7 ~ Bit 11 : reserved Bit 12 ~ Bit 15 : run LUT index Bit 16 ~ Bit 31 : reserved	Read/Write
0xF2F10140	LUT save control register Bit 0 : save command Bit 1 : save ready status(read only) Bit 2 ~ Bit 6 : reserved Bit 7 : set LUT write buffer address to 0 Bit 8 ~ Bit 11 : save LUT index Bit 12 ~ Bit 31 : reserved	Read/Write
0xF2F10144	LUT data register (block write command) Save the first data at low word, then second data at high word Bit 0 ~ Bit 3 : reserved Bit 4 ~ Bit 15 : the second data Bit 16 ~ Bit 19 : reserved Bit 20 ~ Bit 31 : the first data	Write Only
0xF2F10150	**One Pixel Snow Noise Remove** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit 5 : reserved Bit 6 : on/off Bit 7~Bit23 : reserved Bit 24~Bit31 : Threshold Value (T) : If Pixel difference value > Threshold Value, then replace near pixel average Value  **Pixel compared threshold value bit map**	Read/Write
0xF2F10168	**Another sharpness** Bit 0 : presence inquiry (read only) Bit 1 ~ Bit5 : reserved Bit 6 : On/Off Bit 7 : reserved Bit 8 ~ Bit 23 : reserved Bit 24 ~ Bit 31 : sharpness value (10: normal, range 5 ~ 20)	Read/Write

*msb : most significant bit

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7. Video Formats and Modes

IIDC 1.31 defines several video format which determines the video data output from the camera. Overview of these formats is as follows.

- Format 0 : Video formats up to VGA(640 x 480) resolution.
- Format 1 : Video formats for SVGA(800 x 600) and XGA(1024x768) resolution.
- Format 2 : Video Formats for SXGA or higher resolutions (1280 x 960 and 1600 x 1200)
- Format 6 : Still Images
- Format 7 : Scalable images sized (User defined size and position)

Format 0 / Format 1 / Format 2

In these formats frame rates are also pre-defined for each video mode as per the IIDC specification.

There are several defined modes for each format where a mode specifies the size and color information of the pixels. By reading the inquiry register of the camera user may determine which frame rates are supported by the camera. Please refer to the IIDC specification for the details.

Format 7

Format 0, 1, & 2 were defined at the early stage of the digital industrial camera where cameras supported these common VESA compliant resolutions. While user required a flexible and definable format camera manufacturers utilized the user definable Format 7 to meet this demand.

Format 7 is extremely flexible which allows user to define the width, height, position and pixel format of the video data where separate sets of control register exists for each Format 7 mode.

FOculus T series supports Format 7 Mode 0, 1, 2 with the following base address.

Format 7 Mode 0 : F1F00000h Format 7 Mode 1 : F1F00100h Format 7 Mode 0 : F1F00200h

Offset	Name	Description
000h	MAX_IMAGE_SIZE_INQ	Maximum Horizontal / Vertical pixel number
004h	UNIT_SIZE_INQ	Horizontal and Vertical unit pixel number
008h	IMAGE_POSITION	Left / Top position of requested image region (pixel)
00Ch	IMAGE_SIZE	Width / Height of the requested image region (pixel)
010h	COLOR_CODING_ID	Color coding ID from COLOR_CODING_INQ register
014h	COLOR_CODEING_INQ	Inquiry register for color information setting
034h	PIXEL_NUMBER_INQ	Pixel number per frame
038h	TOTAL_BYTE_HI_INQ	Higher quadlet of total bytes of image data per frame
03Ch	TOTAL_BYTE_LO_INQ	Lower quadlet of total bytes of image data per frame
040h	PACKET_PARA_INQ	Unit (Minimum) bytes per packet Multiple by 4 Maximum bytes per packet Multiple by UnitBytePerPacket
044h	BYTE_PER_PACKET	Packet size, Recommended bytes per packet. If this value is zero, shall ignore this field.

Please refer to the IIDC specification for the details.

NOTE : In Format 7 Mode, frames rates may vary which may depend on Size, Color, Maximum byte per packet, shutter and system performances.

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7.1. FO531TB / FO531TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV 422			O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8			O	O	O	
	6	640 x 480	Mono 16			O	O	O	
1	0	800 x 600	YUV 422			O	O		
	1	800 x 600	RGB 8						
	2	800 x 600	Mono 8			O	O		
	3	1024 x 768	YUV 422			O	O	O	O
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8			O	O	O	O
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
2	0	1280 x 960	YUV 422				O	O	O
	1	1280 x 960	RGB 8						
	2	1280 x 960	Mono 8			O	O	O	O
	3	1600 x 1200	YUV 422				O	O	O
	4	1600 x 1200	RGB 8						
	5	1600 x 1200	Mono 8			O	O	O	O
	6	1280 x 960	Mono 16				O	O	O
	7	1600 x 1200	Mono 16				O	O	O
7	0	1600 x 1200	16 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
	1	800 x 600	29 fps 2x2 binning (H&V Binning)						
	2	1600 x 600	29 fps 1x2 binning (V Binning)						

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7.2. FO432TB / FO432TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV 422			O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8			O	O	O	
	6	640 x 480	Mono 16			O	O	O	
1	0	800 x 600	YUV 422			O	O	O	
	1	800 x 600	RGB 8						-
	2	800 x 600	Mono 8			O	O		
	3	1024 x 768	YUV 422			O	O	O	O
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8			O	O	O	O
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
2	0	1280 x 960	YUV 422				O	O	O
	1	1280 x 960	RGB 8						
	2	1280 x 960	Mono 8			O	O	O	O
	3	1600 x 1200	YUV 422						
	4	1600 x 1200	RGB 8						
	5	1600 x 1200	Mono 8						
	6	1280 x 960	Mono 16				O	O	O
	7	1600 x 1200	Mono 16						
7	0	1388 x 1040	20 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
		1388 x 1036	20 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
	1	692 x 516	38 fps 2x2 binning (H&V Binning) for B&W Models Only						
	2	1384 x 516	38 fps 1x2 binning (V Binning) for B&W Models Only						

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7.3. FO323TB / FO323TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV 422		O	O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8		O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
1	0	800 x 600	YUV 422		O	O	O	O	
	1	800 x 600	RGB 8						-
	2	800 x 600	Mono 8		O	O	O		
	3	1024 x 768	YUV 422			O	O	O	O
	4	1024 x 768	RGB 8						
	5	1024 x 768	Mono 8		O	O	O	O	O
	6	800 x 600	Mono 16		O	O	O	O	
	7	1024 x 768	Mono 16			O	O	O	O
7	0	1024 x 768	30 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
	1	512x384	58 (512x384, Format7 mode1, 2x2 binning, B/W only)						
	2	1024x384	58 (1024x384, Format7 mode2, 1x2 binning, B/W only)						

Remark : Color Models outputs Raw Bayer Pattern which is converted by software.

: Unsupported Mode as per IIDC 1.31 Specification

7.4. FO124TB / FO124TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	0	160 x 120	YUV 444						
	1	320 x 240	YUV 422						
	2	640 x 480	YUV 411						
	3	640 x 480	YUV 422		O	O	O	O	
	4	640 x 480	RGB						
	5	640 x 480	Mono 8	O	O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
7	0	640 x 480	60 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
	1	320x240	120 (320x240, Format7 mode1, 2x2 binning, B/W only)						
	2	640x240	120 (640x240, Format7 mode2, 1x2 binning, B/W only)						

Remark : Color Models outputs Raw Bayer Pattern which is converted by software.

: Unsupported Mode as per IIDC 1.31 Specification

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7.5. FO1631TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	3	640 x 480	YUV 422		O	O	O	O	
	5	640 x 480	Mono 8	O	O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
1	0	800 x 600	YUV 422			O	O	O	
	2	800 x 600	Mono 8		O	O	O		
	3	1024 x 768	YUV 422			O	O	O	
	5	1024 x 768	Mono 8		O	O	O	O	
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	
2	0	1280 x 960	YUV 422				O	O	
	2	1280 x 960	Mono 8			O	O	O	
	3	1600 x 1200	YUV 422				O	O	
	5	1600 x 1200	Mono 8			O	O	O	
	6	1280 x 960	Mono 16				O	O	
	7	1600 x 1200	Mono 16				O	O	
7	0	2048 x 1536	10 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						
	1	1024 x 768	26 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						

Remark : Color Models outputs Raw Bayer Pattern which is converted by software.

: Unsupported Mode as per IIDC 1.31 Specification

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7.6. FO1433TB

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	5	640 x 480	Mono 8	O	O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
1	2	800 x 600	Mono 8		O	O	O		
	5	1024 x 768	Mono 8		O	O	O	O	
	6	800 x 600	Mono 16			O	O	O	
	7	1024 x 768	Mono 16			O	O	O	
2	2	1280 x 960	Mono 8			O	O	O	
	6	1280 x 960	Mono 16				O	O	
7	0	1280 x 1024	24 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						

7.7. FO1224TB / FO1224TC

Format	Mode	Resolution		60fps	30fps	15fps	7.5fps	3.75fps	1.875fps
0	3	640 x 480	YUV 422		O	O	O	O	
	5	640 x 480	Mono 8	O	O	O	O	O	
	6	640 x 480	Mono 16		O	O	O	O	
7	0	752 x 480	60 fps Max at Mono 8 (Frame rate may differ in Mono 16 and Bayer)						
	2	752 x 476	30 fps Max at YUV						
	1	376 x 240	110 fps Max at Mono 8 (Frame rate may differ in YUV, Mono 16 and Bayer)						

Remark : Color Models outputs Raw Bayer Pattern which is converted by software.

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8.0 Trouble Shooting

FireWire based camera are operated in connection with system where user may encounter problems as they operate. These problems may orient either from the camera side or the system side that the camera is being used. We recommend reading the manual carefully beginning from the installation to features in concern. Also some system may not have enough power to operate these cameras especially for high resolution and frame rate we recommend the system should be Pentium 4 or higher with 254MB of System memory and Graphic Accelerator with 32MB or more of video memory. When using Windows, due to high graphic requirement and DirectX support we recommend using at least MX400(Nvidia) or Radeon(ATI) or higher.

Frequently asked question in installation is described as follows. (Please carefully check each case.)

8.1 Hardware Related Issues

8.1.1 Camera is not recognized in the device manager

- Please check whether the LED in the back of the camera is ON. If LED is tuned OFF, please check camera connection. Please check the cable connection on both the camera and the PC.
- If you haven't installed the camera driver yet, please refer to the software installation and install the drivers and software provided.
- Please reconnect the camera by plugging out the FireWire cable and plugging in the cable connected on the camera.

8.1.2 LED is OFF while power is provided either by FireWire or external power.

- Please check the supplied voltage and ensure the supplied power is compliant to the operation manual. .

8.1.3 No Image or Black Image Displayed

Check the "Status LED" if it appears Green. If Not, camera is not Isochronous enabled which means not transmitting any image and is in a idle stage.

Check whether the lens is properly mounted and open the iris it to the maximum level.

Check feature values such as shutter speed, gain and exposure. Also check whether the camera is in trigger mode.

8.2 Software Related Issues

8.2.1 System Environment

NET GmbH Cameras are IIDC compliant camera which may be used in various application such as amcap, DirectX SDK, Windows XP capture utility,, Application supporting Twain interface or WDM. It may also be used with image processing library such as IMAQ(labview) or MIL 8.0(Matrox). Please check each application before using the camera and refer to the relative software function for proper operation.

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8.2.2 Appears in Device Manager as unknown device

- Please check the camera driver and update to the latest driver.

8.2.3 Multiple Camera Connection

NET GmbH cameras are compliant with the multi-camera support in the IIDC 1.31 specification. For two or more camera connection, please carefully consider that the FireWire's bandwidth is limited to 400Mbps in a single FireWire bus. This means that if you are planning to run multiple cameras at the same time on higher resolution, you may be required to install more than 1 FireWire adapter to expand the band with by providing more bus. Note that 1 FireWire card is equivalent to 1 FireWire bus as long as they are not interconnected.

The bandwidth of a camera can be calculated as simply applying the following formula.

Data Bit of the Format * Resolution * Desired Frame Rate = Bandwidth(bit/sec)

Ex) Running a 16 bit Image at 800 x 600 would be 16 bit x 800 x 600 x 15fps = 115Mbps

8.2.4 NET's Driver Support

NET's driver and applications are solely designed to work with NET's camera. We cannot guarantee or support other vender's camera to work with the driver and software we provide.

8.2.5 Camera Supported Frame Rate cannot be achieved.

Check the shutter speed. If the shutter speed is too slow, you may not reach your desired level of frame rate.

Check the bandwidth and ensure you are not exceeding the bandwidth limit.

Check CPU load and ensure the computer's CPU is not overloaded. Quit other application and try again.

8.2.6 How to read the serial number

1	2	3	4	5	6	7	8	9	10
FF		Model ID			Serial Number				

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9 Revision History

9.2 Changes Since V 1.0

9.3 Added Since V 1.0

10 Firmware Update

FireWire cameras' Firmware can be updated via the FireWire cable. You my download the latest firmware from our website as follows.

http://www.net-gmbh.com

http://www.net-usa-inc.com

http://www.net-japan.com

When updating the firmware, please carefully follow the instruction provided on our website for firmware update. Also ensure the FireWire connection and DO NOT disconnect the cable in any case during the update.

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11 Technical Support

We ensure the conformity of our product to be reliable and free from defects during manufacturing by testing all the cameras before release. However unexpected problems and technical issues may come up due to the complexity of the product. In case you require technical support contact the agent near you or you may contact us directly with the following information.

Europe	http://www.net-gmbh.com
USA	http://www.net-usa-inc.com
Asia	http://www.net-japan.com

Support Team Email :

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